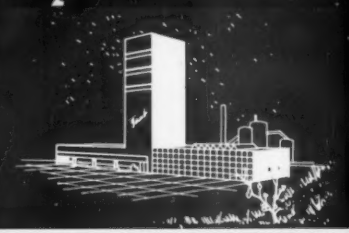
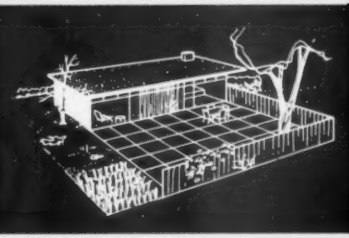
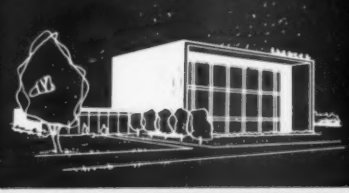
ELECTRICAL CONSTRUCTION AND MAINTENANCE

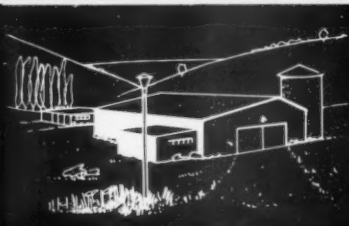
JULY 1951
PRICE TWO DOLLARS





New Frontiers for Electrical Progress





A McGRAW-HILL PUBLICATION

TH ANNIVERSARY ISSUE

New "MIDGET SUBSTATION" makes lamps burn brighter, last longer

G-E INDUCTROL POWER PACK

combines breaker, transformer, regulator in one convenient package

If your plant has combined light and power circuits, you may have noticed how illumination can fall off during plant load peaks. You may also have had trouble with shortened lamp life due to overvoltage.

In either case, here's a brand new "packaged" answer to better voltage regulation—the G-E Inductrol Power Pack.

The new Inductrol unit is, in effect, a midget load-center substation, combining circuit breaker, transformer, and induction voltage regulator in one convenient, space-saving package. It takes the 480 or 600 volts from your power line and converts it to the uniform 120 volts required for maximum lamp output and life. For greater production, more accurate testing, and better performance of electronic equipment, investigate the new G-E Inductrol Power Pack. Contact your G-E sales representative, or authorized G-E agent or mail your coupon today. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

G-E Inductrol Power Packs on factory's roof stanchions are housed in attractive, completely metal-enclosed, easily installed cabinets.

INDUCTROL POWER PACK

General Electric Co., Section J321-73
Apparatus Department
Schenectady 5, N. Y.

Please send me Bulletin GEA-5571 on the new G-E Inductrol Power Pack.

Bulletin needed for:

Reference purposes

Planning an immediate project

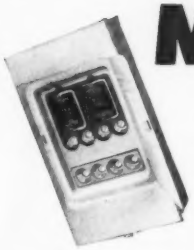
NAME .....

POSITION .....

ADDRESS .....

CITY ..... **ZONE** ..... **STATE** .....

GENERAL ELECTRIC



Murray SWITCHES are EASY TO INSTALL

Cat. No. PD 238 BS—Series
(Old Cat. No. 74-8)

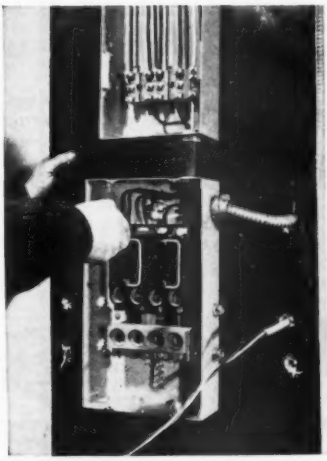
Cat. No. PD 338 BS—Parallel
(Old Cat. No. 77-8)

Murray Combination Main Service and Range Switches are specifically designed and engineered for easy installation. The box has plenty of working space. Solderless connectors help the electrician to hook up wires in a matter of seconds. The one screw cover eliminates the nuisance of taking out four screws.

Murray Combination Switches are available with four, six, or eight branch lighting circuits. The eight Circuit Combination, (illustrated) provides for eight branch circuits, plus three-wire separately fused range connections. An extra tap simplifies hot water heater wiring.

1

Only one screw to take out to remove the cover. Installation photos taken at John J. Tomasulo, Electrical Contractor, Roselle Park, N. J.

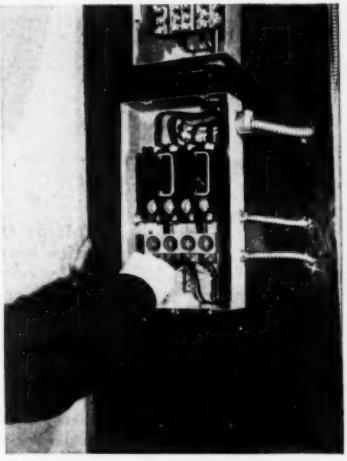


2

Plenty of hand room here. Solderless connectors clamp down on wires for positive, permanent contacts.

3

Branch circuits and neutral are easy to wire because there is plenty of wiring space and the solderless connectors work smoothly and efficiently.



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IF YOU WANT TO INSTALL THE BEST... specify Murray

MURRAY MANUFACTURING CORPORATION
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Service Entrance & Meter Equipment · Magnetic Circuit Breakers · Switches
Current Limiting Reactors · Crows'nest Aerial Ladders

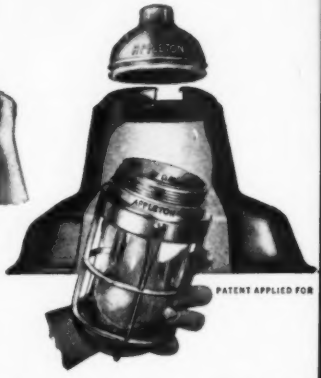
A More Economical Connector...

PATENT APPLIED FOR

Here is a ½", ¾" or 1" thin-wall connector that costs less, installs faster, provides extra wiring room. Eliminates locknuts. Knurled chamfer bites the rim of the knockout to prevent slippage and provide perfect grounding. *Write for Price Sheet TNI-351.*

A More Efficient Lighting Fixture...

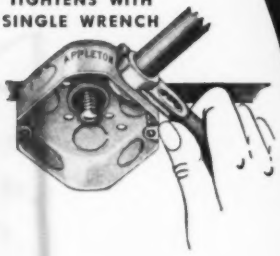
TWIST—
IT'S ON!



PATENT APPLIED FOR

New "V-51" Series. Never before a vaportight lighting fixture so safe, so efficient, so easy to maintain! Exclusive Unit Assembly makes receptacle, globe and guard instantly detachable for re-lamping, *without tools!* Converts for higher or lower wattage lamps just as easily. Reflector has exclusive neoprene rubber ring mount. *Write for Bulletin 5-A.*

TIGHTENS WITH
SINGLE WRENCH



APPLETON ENGINEERING, geared to the ever-growing electrical industry, is continually at work to bring you new products - better products - such as the four recent examples shown here...

A Simpler, Stronger Entrance Fitting...

PATENT APPLIED FOR

Appleton OF-1 and OF-2 Service Entrance Fittings combine convenience, economy and greater weather protection. Single-piece bodies eliminate need for separate cover on entrance head. No covers to become lost before installation, loosen or dislodge after job is done. *Write for Price Sheet TNI-351.*

A Much Safer Fixture Hanger Cover...

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OUTLET BOX EAR

CROSS SECTION VIEW

Positive protection against falling! Safety clips automatically position directly above outlet box ears. Permanently joined to the cover, clips will support weight of fixture even if outlet box screws rust through or vibrate out! An exclusive Appleton safety feature. *Write for Price Sheet TNI-551.*

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EXPLOSION-PROOF FITTINGS • REELITES

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Published for electrical contractors, industrial electricians, engineers, consultants, inspectors and motor shops. Covering engineering, installation, repair, maintenance and management, in the field of electrical construction and maintenance.

50th Year—JULY • 1951

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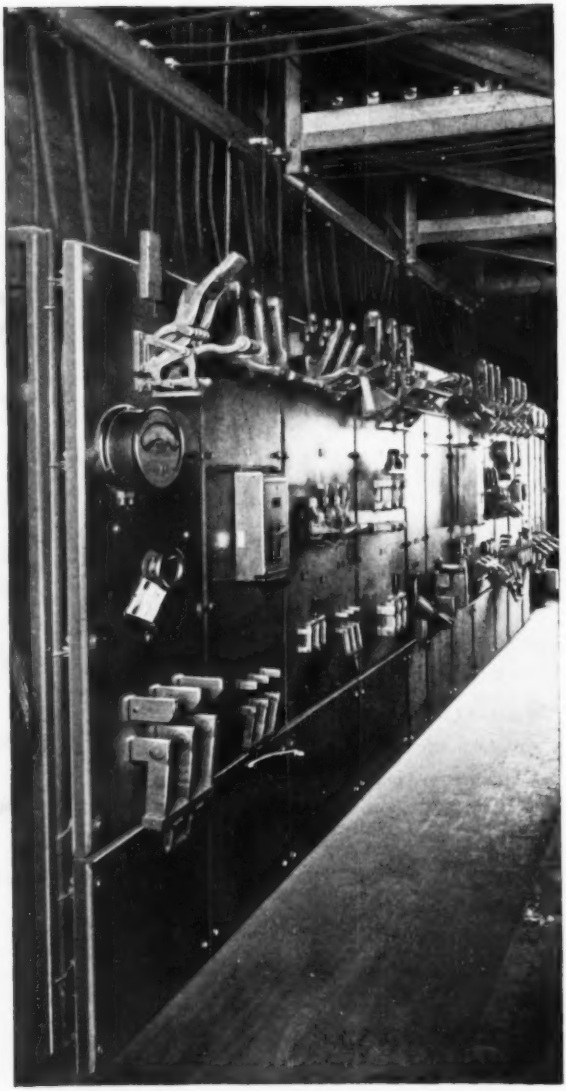
Power bottleneck broken



This is the old open-type switchgear originally installed at the Traylor Engineering & Manufacturing Co. Exposed switches were a safety hazard. With extra feeders added through the years to take care of expansion, the rear of the switchboard had become a tangle of cables, inviting short circuits. Old 240-volt distribution system seriously limited future expansion.

New G-E Metal-Clad switchgear provides for increased output, gives greater safety

Old equipment was inadequate for growing needs

After years of service at the Traylor Engineering & Manufacturing Co., Allentown, Pa., the old-fashioned switchgear shown at left was operating on borrowed time. Already over-loaded through increasing power demands, it had become a bottleneck that limited expansion and hampered efficient production.

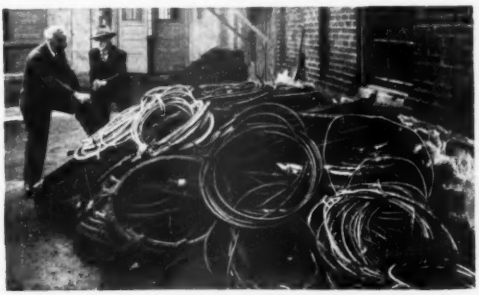
With interrupting devices entirely inadequate to handle the power that could be delivered under short-circuit conditions, any major fault in the system could have been disastrous.

Today this obsolete equipment has been replaced by modern G-E metal-clad switchgear. Dangerous exposed switches have vanished. Interrupting capacity is adequate to take care of abnormal conditions. And a modern high-voltage distribution system assures ample power for years to come. See opposite page.

For information on similar equipment for your plant, contact your G-E sales representative—or write for Bulletins GEA-3083 Metal-clad Switchgear; GEA-3592 Load-center Unit Substations; GEA-3758 Load-center Power Distribution. ***General Electric Company, Schenectady 5, N. Y.***

at this Eastern Plant

Modern G-E Metal-clad Switchgear now installed at the Traylor Company provides greater safety because all parts are completely enclosed. For greater protection against short circuits, separate circuits are isolated in individual compartments. Circuit breakers may be easily removed for inspection, with protection for personnel. Power is distributed from this unit at 2400 volts, replacing the old 240-volt distribution system.



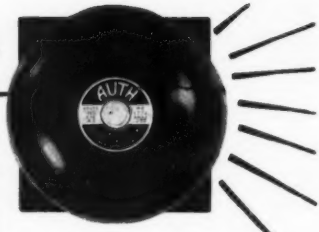
Load-center Unit Substation eliminates long low-voltage feeders—saves copper. 2400-volt power is received at this load-center unit substation and stepped down to utilization voltage on the factory floor. Because the substation is located close to the machines it serves, low-voltage feeders are short, saving copper and giving better voltage control. Discarded cable previously used for low-voltage distribution is shown at left.

GENERAL ELECTRIC

854-35

Complete SIGNALING SYSTEMS

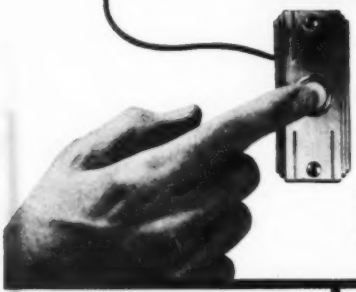
AUTH

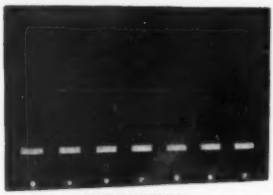


FROM *One* RESPONSIBLE SOURCE

Whether it's a hospital or a school, a housing project or an industrial plant, Auth makes the signaling systems for it — complete! Protect your reputation by specifying reputable systems . . . Eliminate confusion . . . simplify your work . . . and save money for your client.

On your next commission place the responsibility for all signaling and communication equipment with Auth, a Company having more than half a century of experience in this field. You'll be glad you did.





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Nurses' Call, Doctors' Paging, and "In and Out" Register Systems; Clock, Telephone, Fire Alarm Systems; Night Lights.

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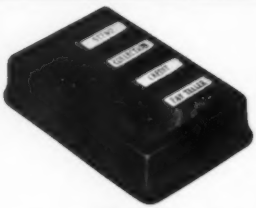
Clock, Program Bell, and Fire Alarm Systems; Telephone and Miscellaneous Signaling Systems.



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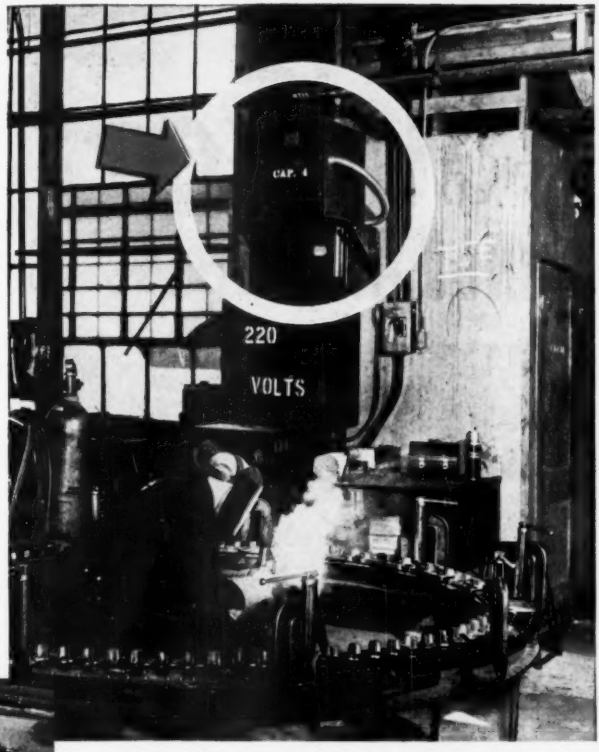
34-20 45th St., Long Island City 1, N.Y.

Electrical capacity doubled without new transformers or wiring

Cleveland Trencher Company installs G-E capacitors to handle twice the load on its electric circuits—finds saving in power costs pays for installation in three years



Cleveland Trencher Company manufactures large trench excavating machinery, uses several welders as well as induction motors for machine-tool drives. Together, these were responsible for the low power factor.

Capacitors were installed in out-of-the-way locations, near motors and welders, and are disconnected from the line when machinery is shut down.

Early in 1948, the Cleveland Trencher Company planned to increase its manufacturing capacity—found itself facing possible electrical overloads. Since power factor was down, the company decided on G-E capacitors instead of new wiring and main transformers. Ninety kvar were installed that year.

TWO YEARS LATER, LOAD WAS INCREASED AGAIN. Again capacitors provided the electrical capacity—60 kvar this time. Altogether load amperes have been doubled since 1948—without new wiring or transformers. And because power factor has been raised from 48 to 98 per cent, the saving in the power bill has already paid for the installation.

CAPACITORS WILL RELIEVE WIRING AND TRANSFORMERS of overload, allow for expansion, and improve voltage conditions. Also, if there is a power-factor or demand clause in your power contract, they often make possible worthwhile dollar savings.

Read what capacitors have done for others. Write for a copy of GEA-5167, "A Way to Cut Power Cost." Address *General Electric Company, Schenectady 5, N. Y.*

This new book can help you

"Capacitors for Industry" is a new, complete book on the application of capacitors in industrial installations. Full of up-to-date information, it is the work of four General Electric application and design engineers. "Capacitors for Industry" is the newest member of the General Electric-Wiley book series. Copies may be purchased from John Wiley and Sons, Inc., 440 Fifth Avenue, New York.

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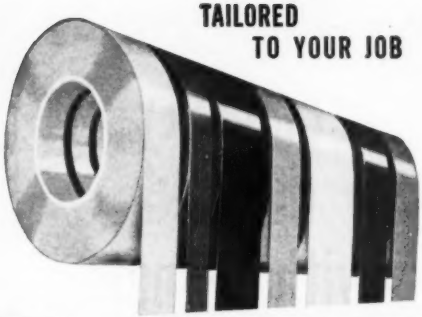
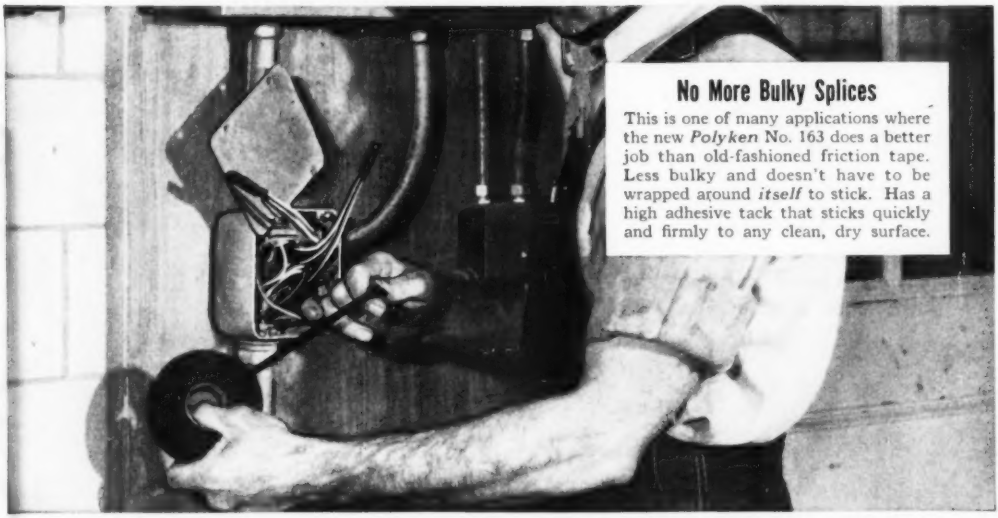




No More Bulky Splices

This is one of many applications where the new *Polyken* No. 163 does a better job than old-fashioned friction tape. Less bulky and doesn't have to be wrapped around *itself* to stick. Has a high adhesive tack that sticks quickly and firmly to any clean, dry surface.

After 70 years—an electrical tape that costs less than friction tape

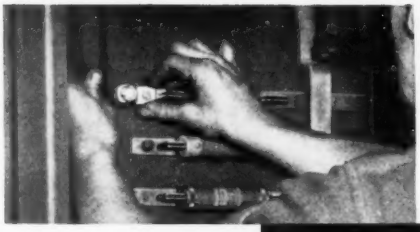
This is the first new thing that's happened in the friction tape field in nearly a century—*Polyken* No. 163. An electrical tape that sticks to any surface as well as to itself. It has higher dielectric strength with less bulk. Forms a better moisture barrier. Doesn't fray. Sticks better and is easier and cleaner to handle.

All this, new *Polyken* No. 163 brings you . . . yet costs less than old-fashioned friction tape! See your Polyken distributor today.

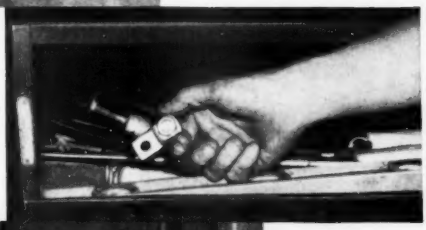
FREE BOOKLET

To learn more about revolutionary new tape, *Polyken* No. 163, write for free folder, "Test It Yourself!" Address *Polyken*, Dept. ECG, 222 W. Adams St., Chicago 6, Ill. Or call your distributor.

Polyken Industrial Tape, Department of Bauer & Black, Division of The Kendall Company

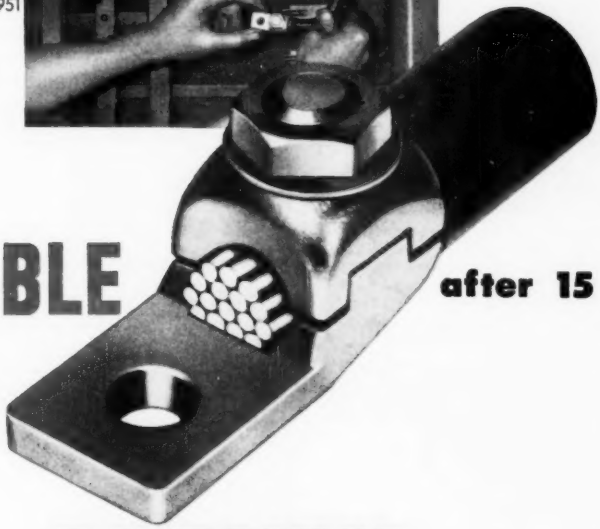


① INSTALLED 1936



② SALVAGED

③ RE-INSTALLED 1951



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BURNDY QIKLUG

After 15 years, this Qiklug is ready for another long stretch of service. Quickly installed, quickly removed—a wrench does it. Clean, rugged threads resist stripping. That's why compact, efficient Qiklug connectors can be used over and over again. Today, especially, it pays you to take advantage of Qiklug's salvage value—to help you stretch stock and cut costs.

BURNDY CONNECTORS

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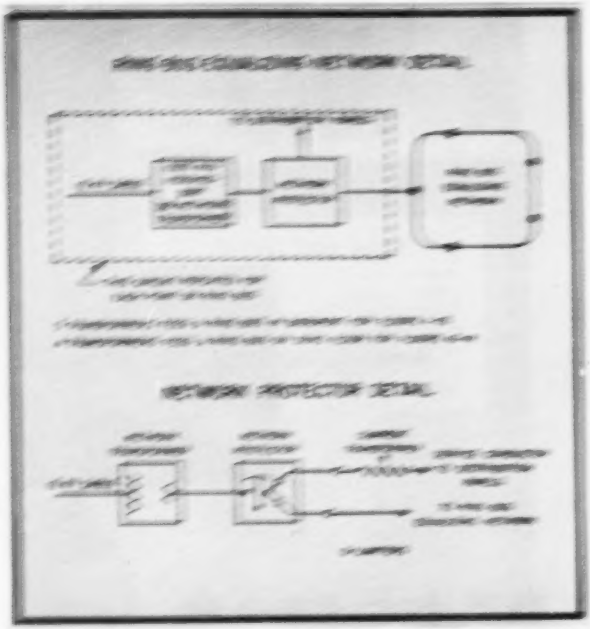
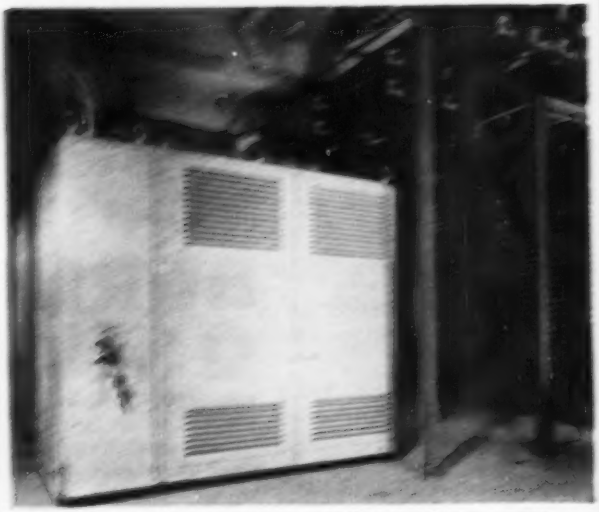
281

New 31-story building uses modern ring bus





protected against power failure equalizing network made from

AMERBESTOS

525 WILLIAM PENN PLACE, PITTSBURGH, PA., is modern from the word go. It has all the things that make a building easy to work in and easy to maintain.

This handsome building is *completely* air-conditioned. It has stainless steel windows and spandrels, "Q" floors for flexible floor layout, movable steel wall partitions, acoustical ceilings, glareless fluorescent lighting.

But to electrical engineers, the thing that stands out most is the advanced electrical distribution system. It features a ring bus equalizing network that guarantees power to the entire building even if one of the main 1,000 KVA transformers should fail. The diagram shows how it works:

The output of each 11,500/120-208 Y 3ϕ network transformer is fed through the network protector to the ring bus and the distribution panels. If a fault should develop in one of the transformers the network protector would kick open. But the affected distribution panels would still be fed by the other transformers through the ring bus network, which is well protected by limiters. In other words, the voltage in all five sections would be automatically equalized in case one section should fail.

As a further precaution, the power company furnishes current from the power station via 5 separate feeders through a ring bus. Failure at the power station would probably affect only one feeder, but all transformers would still be served. Over-all building power would continue, uninterrupted.

American Steel & Wire Company furnished the bulk of the wiring that will assure unfailing power to this great building—from the 3,000,000 C/M Amerbestos main ring feeder and thousands of feet of 500,000 C/M Amerbestos secondaries—to the millions of feet of Amarine-Amperox heat and moisture resisting circuit wiring.

But as every designer and contractor knows, supplying the proper wire and cable is only half the job. Equally important is the application experience of the supplier. At 525 William Penn Place we worked closely with everyone concerned with the electrical installation. As a result of this cooperation, the work was finished with complete coordination.

When American Steel & Wire Company supplies your electrical wire and cable, you can be sure of this same cooperation from our highly-skilled engineers. We'll be glad to discuss the entire range of special purpose conductors available. We'll help you select the best and most economical grade for your particular job, and we'll give you valuable assistance on installation problems.

For more information, get in touch with our nearest district engineer or write American Steel & Wire Company, Rockefeller Building, Cleveland 13, Ohio.

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American Electrical Wire and Cable

UNITED STATES STEEL

ORANGEBURG LAYS FASTEST AND AT LOWEST COST

● That's the reason why more contractors than ever are using Orangeburg Conduit.

Today's conditions call for fast action . . . even with fewer people. Contractors get that action from Orangeburg. It's so light a child can handle it. *Standard* 4" weighs only two pounds per foot . . . heavier-walled *Nocrete* only 3.6 pounds per foot. Orangeburg is easily sawed and tooled on the job. Tapered Sleeve Joints also speed assembly and save time and work.

LIFETIME CABLE PROTECTION

Orangeburg is the conduit most widely used by public utilities, municipalities and contractors . . . and has been for 58 years. They know they can depend on Orangeburg to provide a permanent raceway for the lifetime protection of cables underground.

For Multiple Duct Jobs. ORANGEBURG STANDARD . . . installed with concrete encasement . . . is the economical construction where banks of three or more ducts are involved.

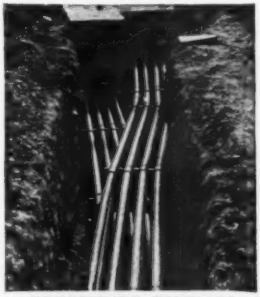
For Single or Double Duct Runs . . . use NOCRETE, installed *without* concrete encasement. Contractors find it profitable to use *Nocrete* . . . when conditions are favorable . . . for such installations as factories, schools, colleges, hospitals, drive-in theaters, telephone and other communications systems . . . also service entrances, parkway and suburban lighting, airport lighting and communication.

ORANGEBURG NOCRETE

These Time-Tested Features Keep Orangeburg the Leader in Every City and State

1. Will not corrode. Lasts indefinitely. 2. Impermeable wall and tight joints prevent corrosive ground waters from entering. 3. Lays faster and at lower cost than any other type of conduit. 4. Low coefficient of friction keeps pulling tensions on cable to minimum. 5. Protects cable sheath from abrasion when pulled in—also from wear during cable movement resulting from alternate expansion and contraction with changing loads. 6. Resists acids, alkalis, salt, grease, oil. 7. Light, easy to handle and tool on the job. 8. Tough, resilient—will not crack or break when properly handled.

The Orangeburg trademark identifies these valuable qualities. SEND FOR *Free*, Illustrated Folder showing Orangeburg Bend Sections and Angle Couplings. Write today to Dept. EC-3, Orangeburg Manufacturing Co., Inc., Orangeburg, N. Y.



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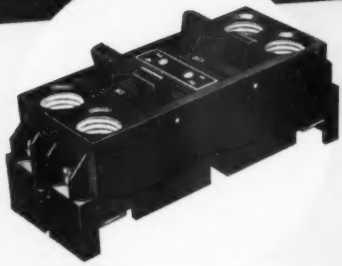
DESIGN LEADERSHIP

NEW LOW COST FUSIBLE LIGHTING PANELBOARDS



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NTPR Panelboards are available up to 40 circuits for either 1ø 3-wire or 3ø 4-wire applications. 17" wide boxes provide 4" minimum wiring gutters. Single door flush or surface fronts include directory frame and flush lock.

NTPS Load Centers with 12" wide boxes provide up to 20 circuits for 1ø 3-wire or 3ø 4-wire services. Flush or surface single door fronts include directory frame and flush spring catch.

NTPS and NTPR devices are Underwriters' approved for general service application

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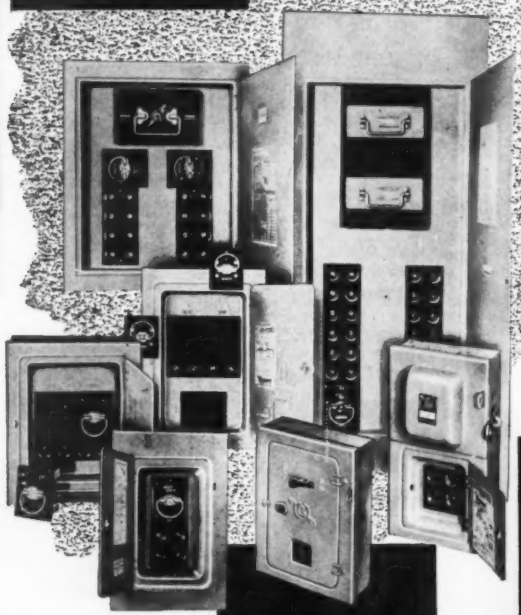

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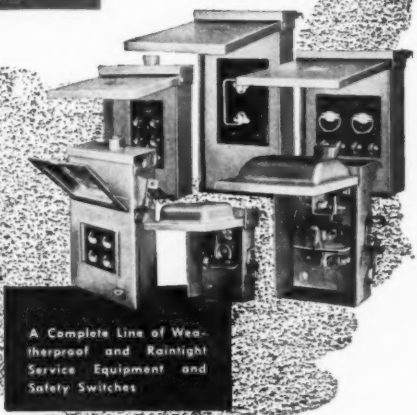

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ENCLOSED SAFETY SWITCHES
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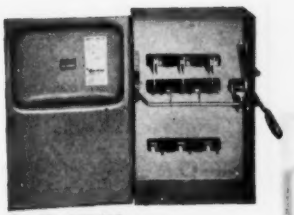
H.P. rated. 30 to 1200 Amps, up to 600 V. Fusible (with or without groundable solid neutral) and non-fusible, for 2, 3, 4 and 5 poles. Positive switching mechanism—quick-make and quick-break. Interlocking cover.



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TYPE C ENCLOSED SAFETY SWITCHES . . . . . ☐

H.P. rated. 30 to 200 Amps, up to 600 V. 400 and 600 Amps up to 250 V. Fusible (with or without groundable solid neutral) and non-fusible, for 2, 3, 4 and 5 poles. Positive switching mechanism—quick-make and quick-break.

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For Cartridge Fuses . . . . . ☐

H.P. rated. 30 to 600 Amps, up to 250 V. Fusible (with or without groundable solid neutral) and non-fusible, for 2, 3, 4 and 5 poles. Spring actuated quick-break.

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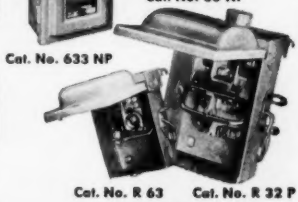
For Plug Fuses

Front Operated Toggle . . . . . ☐

H.P. rated. 125-250 V. Fusible (with or without groundable solid neutral) and non-fusible for 2 and 3 poles. Snap-action, toggle actuated. Dependable, full-floating contacts. With or without dead front plate. Also available—Dual Water Heater Switch—Two 30 Amp, 2 pole, plug fuse toggle switches in one cabinet.



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Cat. No. R 63 Cat. No. R 32 P

Side Operated . . . . . ☐

H.P. rated. 125-250 V. Fusible (with or without groundable solid neutral) and non-fusible for 2, 3 and 5 poles.

Cat. No. 634 PWX, Dual Water Heater Switch

RAINTIGHT ENCLOSED SAFETY SWITCHES . . . . . ☐

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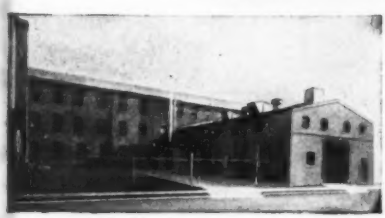

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We Mobilize for Freedom

CONTROLS . . . A Two-Edged Sword

It may seem dangerously premature to talk about getting rid of emergency government controls while all-out war is still an imminent possibility.

But success in this strange struggle for our freedom into which the Russian Communists have plunged us requires that we:

1. Maintain a whole battery of controls designed to speed defense production and curb inflation, and at the same time

2. Work to end the controls at the earliest possible moment.

Here is the reason why this editorial—fourth in a special series on mobilization for defense—is devoted to the need for a speedy release from controls.

If the Russian Communists can force us to maintain indefinitely the present system of government controls, they will have won a tremendous victory. They will have saddled us with a system of collectivism which, over a period of years, would be fairly certain death to freedom of business enterprise.

Make no mistake about it. This is not an argument against emergency controls. We need controls now to break a right of way for our mobilization program through the business boom. Indeed, the third editorial in this special series was titled "Why Controls Are Necessary." It stressed both the need for controls and the need for positive cooperation to make them work.

Controls Can Undermine Our Economy

But these controls surely chisel at the foundation of our normal economic system. So long as we have them, many if not most key business decisions will be made in Washington bureaus rather than in the free market place. For example, the *National Production Authority* administers a *Controlled* Materials Plan (italics ours) which directs the flow of basic metals, and decides who can use them for what purposes.

Happily, the people who operate these controls are not using the methods of a secret police state.

Even more happily, most of the leaders who have been drafted to manage the controls are not in love with their jobs. They are doing their best in the thankless task of making controls work. They recognize the danger of chronic controls.

But the fact remains that our economy is

operating under arrangements which carry it a long way toward the pattern of centralized control the Russians would inflict on the world.

The Wilson Plan

A plan for getting rid of these controls has already been developed. It was put together by our Director of Mobilization, Charles E. Wilson—while he was working day and night to set up the necessary emergency controls.

The Wilson Plan—if we escape all-out war—will strengthen our defenses and our economy. By 1953, it calls for:

1. Providing the weapons to equip an armed force of 3½ to 4 million, together with a supply of weapons for our allies.

2. Building a stockpile of weapons which, with current production, would be sufficient to carry on an all-out war for a year.

3. Building the manufacturing capacity by which we could rapidly expand our production of weapons if all-out war should come.

4. Increasing the productive capacity of industry enough to resume the expansion of our civilian economy.

With these jobs done our economy would be big enough and strong enough to meet both civilian and military requirements. And the government controls needed for mobilization could be speedily dropped.

Call for Sacrifice

The Wilson Plan requires a major effort—it means spending more than $50 billion a year for mobilization. That is almost 20 percent of our total production. And this cannot be done without sacrifice. For a time, particularly in the next year, living standards will drop.

But the sacrifice required is amazingly small. At the peak of the defense effort, civilians will still have available to meet their needs about as much as they did in any year before 1948.

To make the Wilson Plan succeed we must curb inflation. A second year of inflation such as that which we have had since the Korean war started would multiply disastrously the costs of our defense program. One key part of a successful program to curb inflationary pressure, which soon will be building up again, is a pay-as-we-go tax program. The second editorial in this series urged that we do our utmost to pay as we go.

We Cannot Out-Control the Communists

But, above all, to make the Wilson Plan work we must keep our sights set on the crucial importance of increased production. Our problem is to increase our capacity to produce so that we can carry both a major military program and an expanding civilian economy for as many years—General Bradley thinks it might be fifteen or twenty—as the menace of Russian Communist aggression persists.

If we do not produce enough to do this double job, we shall be confronted with the prospect of having to live indefinitely under government controls of the sort that have been set up since the start of the Korean war. That would be delightful to the Russian Communists. It would go far toward making over our economy on the Moscow model.

Even if we wanted to, we never could hope to out-control the Russians. They are miles ahead of us in that line. But we can out-produce them, by a tremendous margin. By doing that we shall travel the surest road to victory.

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Struck 12 times during a single storm and 48 times in one year, the Empire State Building disproves the old saying that "lightning never strikes twice in the same place."

YOU NEVER KNOW WHERE, WHEN, OR HOW OFTEN LIGHTNING WILL STRIKE . . . but you can secure safe, permanent and economical grounding protection when you install Copperweld* Ground Rods and Clamps. For every grounding application requiring the use of driven electrodes, these superior ground rods offer you these important advantages:

1. *Molten-Weld*—Permanent interlocking weld between the copper and alloy steel eliminates possibility of electrolytic action. No other ground rod has this inseparable union, accomplished only by the proved Copperweld Molten-Welding process.
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Start now to reduce outages and insure continuity of service by using Copperweld Ground Rods and Clamps. They provide safe, permanent, low-cost grounding protection at all types of locations—at poles, at towers, at power stations, at substations, at buildings — and for all grounding purposes.

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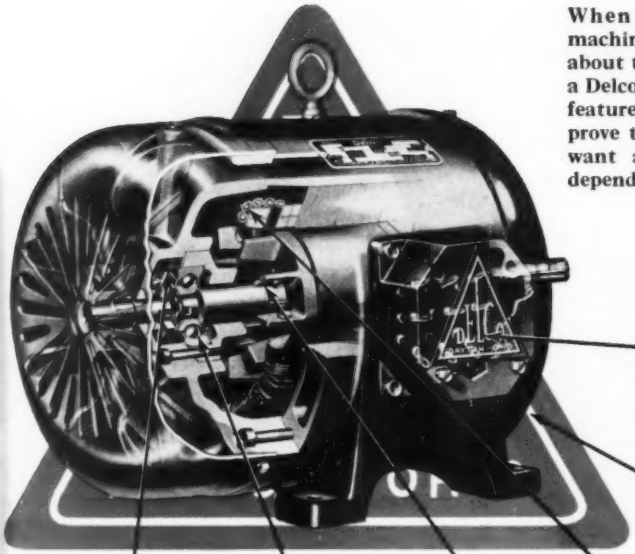
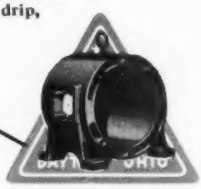
When you invest in new production machinery, it pays to be just as particular about the motor that drives it. Look inside a Delco Motor. You'll see extra engineering features, extra care in construction, that prove to you a Delco is built the way you want a motor built. Specify Delco for dependable power day in, day out.



WATER-TIGHT CONDUIT BOX
Protects against drip, splash



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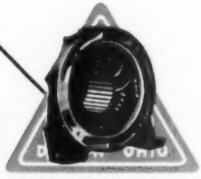
Reduces vibration, wear



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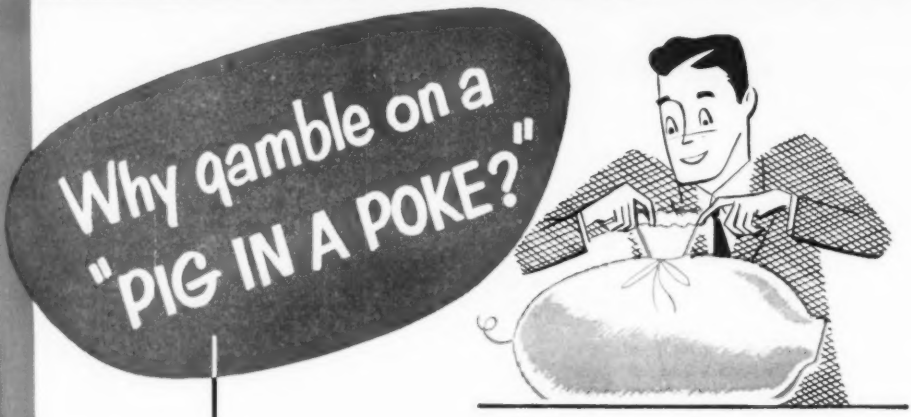

you know Exactly how every FLEUR·O·LIER luminaire will perform

There's no guessing about how a Fleur-O-Lier lighting installation will perform. You know in advance the tested, certified illuminating performance.

This certainty of results is possible because for every Fleur-O-Lier fixture there is available complete, authoritative performance data. Thus, you get the precise lighting results specified by the architect, contractor or lighting advisor.

Fleur-O-Lier gives you these advantages:

1. The Fleur-O-Lier Index System Rating, assigned by Electrical Testing Laboratories, Inc., after careful test, tells exactly what the illuminating characteristics of the luminaire are.

2. Complete photometric data is compiled by ETL.

3. Coefficients of utilization are computed by ETL. This data is essential in selecting the most suitable fixtures for the installation.

4. Certification by ETL assures the fixture was made to the rigid specifications covering electrical and mechanical features.

All this essential information lets you know in advance just what you're getting when you specify Fleur-O-Lier.

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Manufacturers

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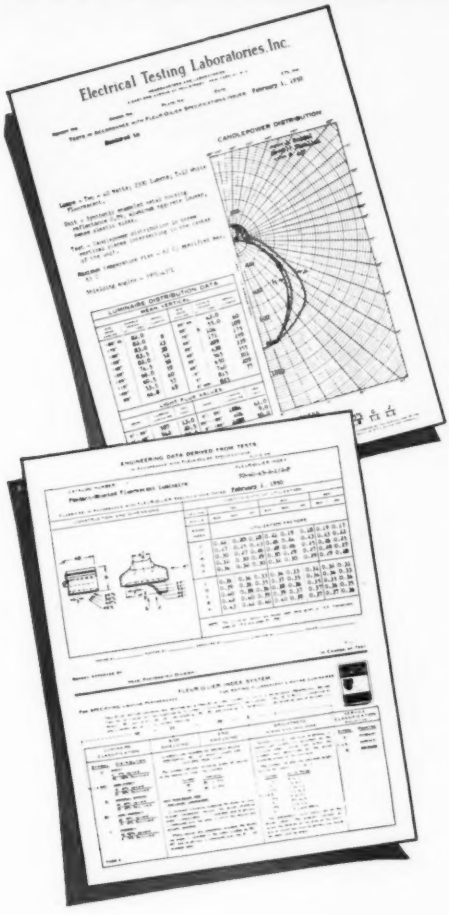
Fleur-O-Lier is not the name of an individual manufacturer, but of a group of fixtures made by leading manufacturers. Participation in the Fleur-O-Lier program is open to any manufacturer who complies with Fleur-O-Lier requirements.



FLEUR-O-LIER DATA SHEETS give complete information

Manufacturers of Fleur-O-Lier fixtures provide Standard Data Sheets which give complete and detailed information on each Fleur-O-Lier fixture. Here, brought together on one sheet, is everything you need to know about the fixture — shielding — brightness — light distribution data — utilization factors — and construction and dimension details.

With more than 300 Fleur-O-Lier fixtures available from 25 different manufacturers — you have a wide selection of units to meet the needs of any installation.

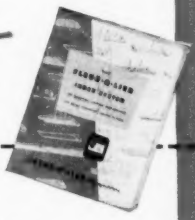
How the Fleur-O-Lier System Enables You to Specify and Select the Right Units

The Fleur-O-Lier Index System makes the specification and selection of lighting fixtures extremely simple. Merely ask the specification writer to express the desired illumination characteristics in the simple formulas of the Fleur-O-Lier Index System.

Then the selection of lighting equipment that fits exactly the requirements of the installation is easy. Choose from fixtures that have the requested Fleur-O-Lier Index System formula and you know you'll get the desired lighting results.

Don't take chances . . . specify Fleur-O-Lier and *know* what you're getting!

Free Booklet



Write for your free copy of the new booklet giving complete details of the Fleur-O-Lier Index System.

Ask also for Electrical Testing Laboratories' report on performance ratings assigned to the 300 Fleur-O-Lier fixtures.

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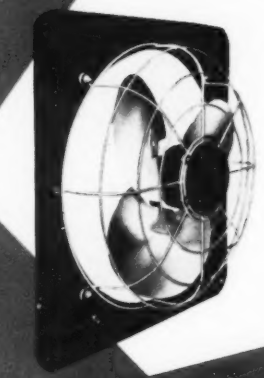
Model V-520A 20" Vent Fan . . .

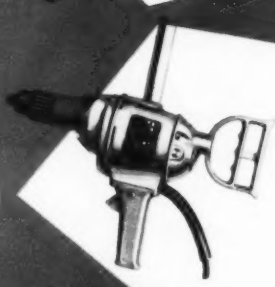
. . . newest addition to the famous Signal Challenger Vent Fan line! Has that "everything *plus*" appearance and construction that sells and *stays* sold—hums its way through year after year of solid service! For yourself—for customers you want to keep coming—use and recommend the V-520A. It does a job of work!

Guarded frame, oilless type bearings, shaded pole motor, rubber mounted blade, minimum weight because of highest quality materials and construction throughout. The Challenger V-520A operates in either vertical or horizontal position. Durable baked, black wrinkle finish. Three-speed controller available.



SIGNAL Portable Electric Drill OB-5

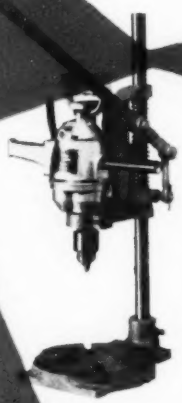
Here's a Standard Duty ½" Drill that Signal is *proud* to offer the trade! Because the OB-5 is a *craftsman* tool—*delivers* the speed, power, balance and stamina the experienced man has a right to expect . . . the solid construction to withstand "new man" roughing! There is no better drill for general duty work at this price—few at any price. *See* the OB-5—*try* its balance and "feel." You'll agree with us when we say "There's a *drill*!".



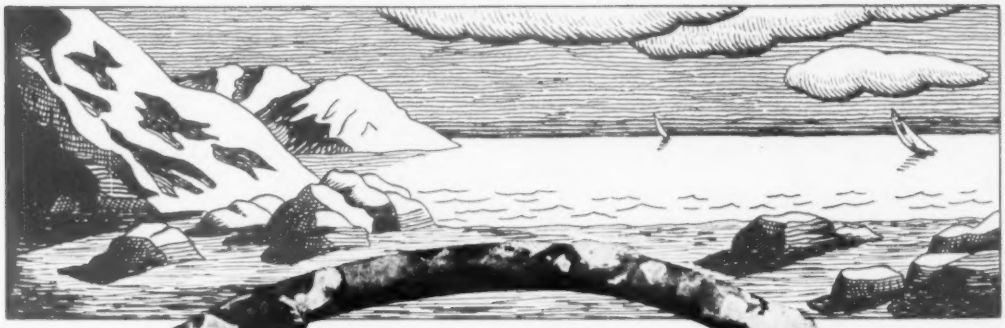
SIGNAL DS-2 Drill Stand

For ½" drills and built as the sturdy companion for the OB-5 Drill.

Features • Converts OB-5 Drill to stationary drill press. • Assures drilling accuracy on small parts. • Makes hole-saw work easy. • Slots in base hold work in place. • Base is drilled, ready for mounting. • Sturdy, adjustable tool bracket allows quick changes in height . . . swings in arc to desired position. • Not necessary to remove drill handle.



SIGNAL ELECTRIC MANUFACTURING COMPANY
MENOMINEE, MICHIGAN



NEITHER SURF, NOR ROCKS, NOR BARNACLES....

This "beat-up" looking piece of TIREX Cord is a veteran of many battles with the sea. Here's an excerpt from a field report describing its performance.

> "TIREX Cords and Cables have been found to be the only product that can be counted upon to withstand consistently the severe abuse to which they subject cables in their research work. One instance was given: A TIREX Cord led from a heavy instrument located on the ocean bottom several hundred yards from the shore, through the surf and over a rocky water line to the point where they were taking readings. After an unexpected storm they found this heavy instrument cast far up on the beach with the cord still attached, but in a tangled mass. The instrument was a total loss but the cord was intact and was used again on many subsequent occasions without requiring repair."

Isn't that the kind of service you want from your portable cords and cables? Of course it is! You can be sure to get it if you specify and be sure you get Simplex-TIREX Cords and Cables. They're a product of Simplex Research.

Simplex Research gave you the first heavy duty, rubber-jacketed portable cord or cable; the first low water absorption insulation; the first rubber-jacketed underground cable. Besides these notable "Firsts" Simplex Research has provided a great many developments which have enriched the art of cable design.

TIREX is not made nor recommended to be used under water. However, the spectacular life of this TIREX Cord illustrates perfectly the inherent ruggedness of TIREX. This ruggedness has been deliberately built into all TIREX Cords and Cables. It is one of the "plus values" that you get when you use TIREX.

SIMPLEX-TIREX IS A PRODUCT OF SIMPLEX RESEARCH

SIMPLEX-TIREX

SIMPLEX WIRE & CABLE CO., 79 SIDNEY ST., CAMBRIDGE 39, MASS.

Wagner

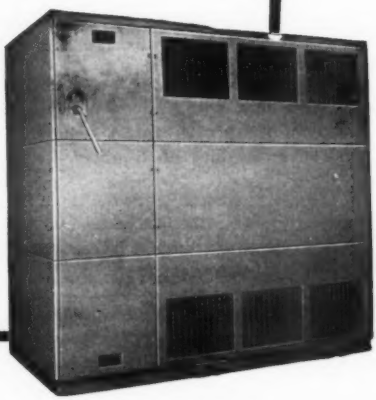
PRODUCTS for INDUSTRY -- Designed for Dependability

ELECTRIC MOTORS

Wagner Motors are built in a wide range of types and sizes with electrical and mechanical characteristics that meet almost any industrial requirement. Wagner can fit the RIGHT motor to your job . . . a representative will be glad to help you with your motor problems—consult the nearest Wagner branch. Bulletin MU-185 gives full information on Wagner's complete line of motors.

TRANSFORMERS

Wagner's diversified line of transformers for industrial use makes possible a wide selection from standardized designs. No matter what your requirements may be, Wagner can furnish the exact type of transformer to meet your needs. The Wagner line includes oil-filled, dry-type and unit substation transformers. Bulletins TU-180 and TU-181 give information on the complete line of Wagner distribution and power transformers.



®Wagner Electric Corporation 1891 WE 1951

WAGNER ELECTRIC CORPORATION
6413 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

BRANCHES IN 31 PRINCIPAL CITIES

M50—13

RECORD NEW *Mass Production! Lower Price!*

For **UNION Conduit End** *Bushings!*

Added Protection At Lower Cost!

SIZES 1/8" to 6"

UL

Mass production wins again! The new high in production of Union Conduit End Bushings now makes possible substantial savings in wiring with Insulated Bushings.

Since Union's Insulated Bushings are now competitively priced with metallic bushings, the last barrier to the universal use of insulated conduit-end bushings has been removed.

Contractors can depend on Insulated bushings for their extra protection and safety without the deterrent of higher bushing costs.

In sizes 1¼" and up where strength counts, be sure you SEE THE CANVAS. Then you know that no substitution of a weaker material can be made.

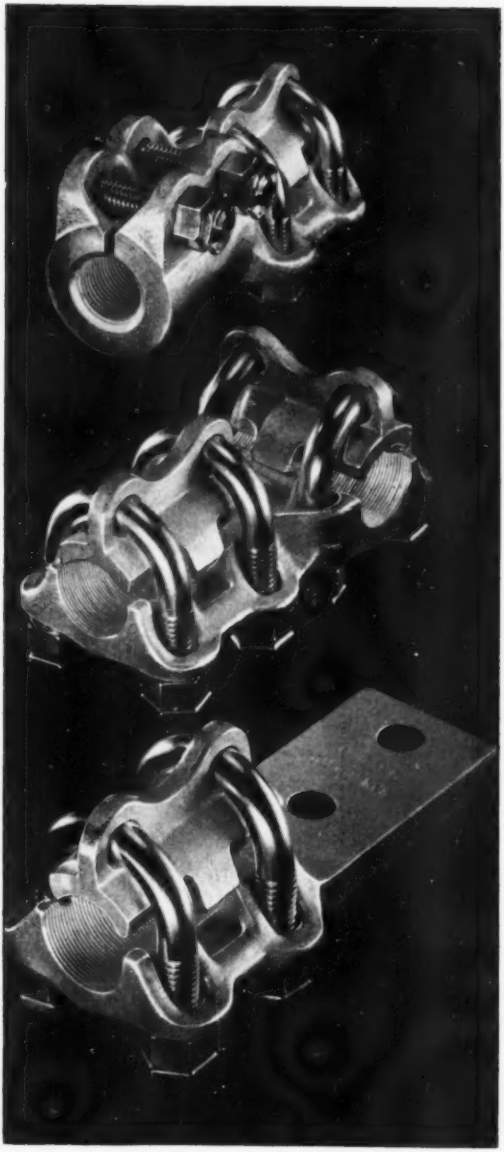
UNION INSULATING CO.

PARKERSBURG, WEST VIRGINIA

Low joint resistance . . . high resistance to corrosion

POWER CONNECTORS

Silver plated on all contact surfaces!



Silver on all current-carrying surfaces is just one of the ways in which G-E power connectors reduce joint resistance and minimize corrosion. Carefully regulated copper content of connector alloy provides current-carrying ability equal to that of conductor. Sharp, machine-serrated contact surfaces bite into the conductor, giving a permanent high conductivity joint that resists vibration and maintains positive pressure at all times. Interlocking sides confine the strands of the cable within the enclosure, reducing inter-strand resistance and taking full advantage of the cable's current-carrying capacity. Non-corrodible hardware of high-strength bronze alloy assures permanent tightness of connections.

There's a wide range of types—straight, tee, block, angle, parallel, expansion, ground, and many others. Why not place a trial order with your G-E sales representative? Write for Bulletin GEC-400—it contains 44 pages of valuable connector information. Section 856-57, General Electric Company, Schenectady 5, N. Y.

856-57

GENERAL ELECTRIC

you'll get 50% more lamp life*...

with CERTIFIED BALLASTS

• Recent experience has shown that fluorescent lamps last 50% longer when powered by CERTIFIED BALLASTS rather than poor quality ballasts that are commercially available.

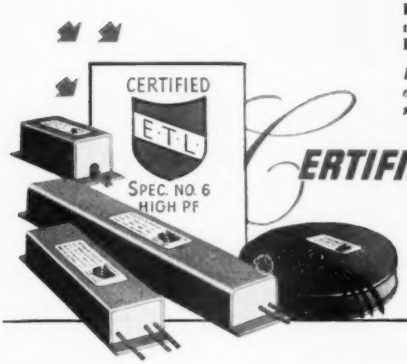
This, together with the fact that CERTIFIED BALLASTS assure rated light output and long, satisfactory ballast life makes CERTIFIED BALLASTS a *must* in selecting fluorescent equipment.

CERTIFIED BALLASTS are made to exacting specifications, then tested and checked by Electrical Testing Laboratories, Inc.

*Lead lamps on a two-lamp ballast.

• Complete information on the types of CERTIFIED BALLASTS available from each participating manufacturer may be obtained from Electrical Testing Laboratories, Inc., East End Avenue at 79th Street, New York, New York.

Participation in the CERTIFIED BALLAST program is open to any manufacturer who complies with the requirements of CERTIFIED BALLAST MANUFACTURERS.

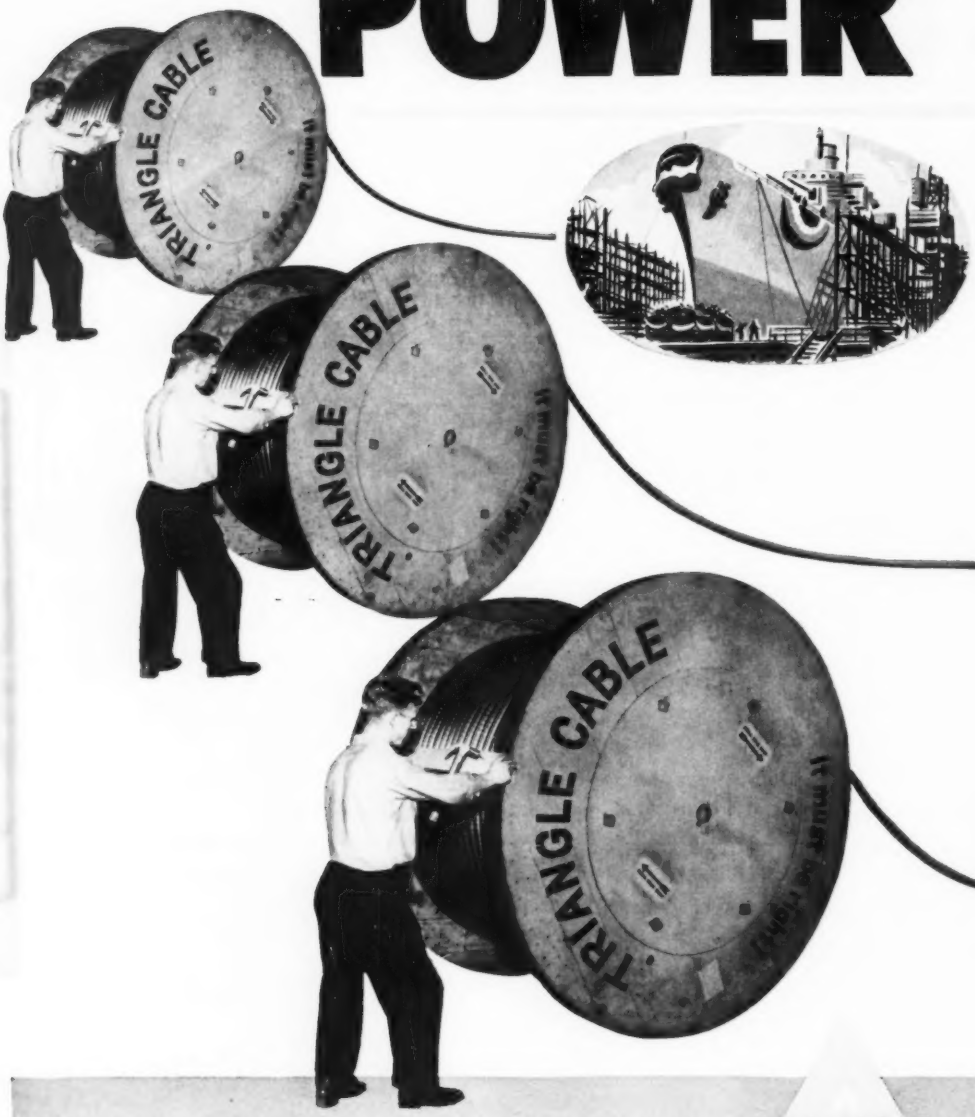


CERTIFIED BALLAST MANUFACTURERS

Makers of Certified Ballasts for Fluorescent Lighting

2116 KEITH BLDG., CLEVELAND 15, OHIO

POWER



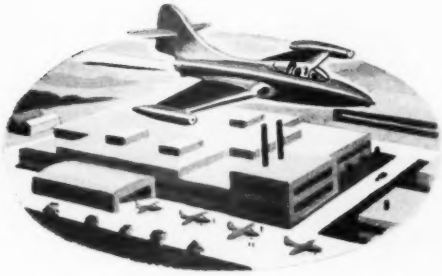
"Glazon" Building Wire • Bare Wire • Armored Cable • "Glazon" Non-Metallic Sheathed Cable • Service Entrance, Service Drop, Varnished Cambric Braided or Leaded, Trioprene Trench, Power and Parkway Cables • Rigid Conduit Hot-Dipped Galvanized • Electric Metallic Thin Wall Conduit • Flexible Steel Conduit.

TRIANGLE

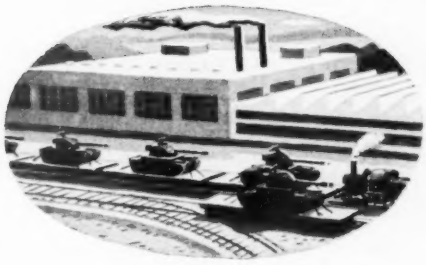
IT *MUST* BE RIGHT

when you need it!

TRIANGLE products keep power flowing—to factories producing jet planes, to shipyards, atomic energy plants, tank and gun assembly lines—to *all* defense industries.



TRIANGLE produces a full line of quality wire, cable and conduit—products that will stand up under the most severe conditions—products that will not fail.



To be certain YOU get power when you need it—specify TRIANGLE.

Ask your electrical distributor. He knows—"It *Must* Be Right!"

TRIANGLE CONDUIT & CABLE CO., INC.

NEW BRUNSWICK, NEW JERSEY

Defense Production

makes more important than ever the Specification of Lighting Units that meet

RLM High Quality Standards

for Efficiency, Durability and Uniformity

Vital to defense and essential civilian production, are lighting units that *can be depended upon* to provide the right quantity and quality of light, economically, dependably and with a minimum of servicing need and maintenance cost.

Defense production demands lighting equipment with the ability to *sustain its rated light output* efficiency over hundreds of cleanings so that the proper high illumination levels may be maintained. It demands the *durability* found so essential to industrial lighting and the avoidance of production interruptions and inefficiency due to abnormal wear, distortion or breakdown. It demands fullest *protection from glare* through proper diffusion and shielding.

All of these, and many other conditions for proper lighting of defense plants can be met through the specification of RLM-Labeled Lighting Units. All units bearing the RLM Label are warranted by Electrical Testing Laboratories to conform to the minimum standards established by the RLM Standards Institute for efficiency, durability and uniform quality.

FREE RLM BOOKLETS containing complete specifications for all RLM-Certified Industrial Fluorescent and Incandescent Lighting Units and the names of all manufacturers of RLM-Labeled Units may be obtained by writing: RLM STANDARDS INSTITUTE INC., Suite 819, 326 West Madison Street, Chicago 6, Illinois.

Specification of RLM-Labeled Units Assures Conformance to ALL these Essentials of Defense Production Lighting

DIFFUSION WITH HIGH REFLECTION FACTOR
RLM Porcelain-Enameled Steel Reflectors must have a mean reflection factor of 82% . . . an assurance of more light for the money. Porcelain enamel reflecting surfaces *diffuse* light from the lamp and help provide proper *quality* of illumination.

TOP QUALITY PORCELAIN-ENAMELED REFLECTORS
RLM Reflectors are built of not less than .032" reflector steel covered with .025" fused on porcelain enamel that will not chip, corrode or deteriorate under industrial operating conditions.

APPROVED REFLECTOR DESIGN
Reflector design of RLM Units conforms to specifications embodying approved practices of illuminating engineering.

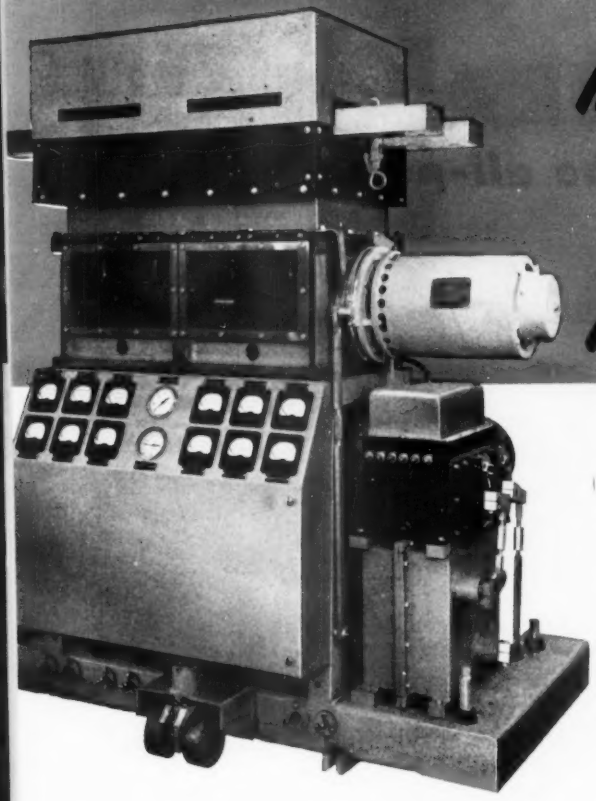
HIGH POWER FACTOR BALLASTS
RLM Standards specify the use of certified ballasts which last longer, because they are designed to prevent excessively high temperature operation.

UNIFORM QUALITY
RLM Standards insist on the maintenance of uniform quality as to materials and construction, thus assuring the buyer of uniform lighting performance from each unit installed.

RLM STANDARDS INSTITUTE
INCORPORATED
The letters RLM stand for Reflector and Lighting Equipment Manufacturers

M5518

New High Efficiency in Low Voltage Power Conversion



forecasts significant savings for American industry

In designing and constructing equipment for the conversion of alternating into direct current, it has always been obvious to engineers that if an automatic switch could be built which would connect the a-c voltage to the load in such a way and in such time that the current would flow through the load in one direction only, d-c current satisfactory for most purposes would be produced.

Engineers long envisioned a contacting mechanism for power conversion; but with the development of mercury arc rectifiers, contact converters were practically forgotten in this country.

Yet the need for high efficiency conversion at low voltages remained strong, and the idea of mechanical rectification persisted in some quarters.

The I-T-E Circuit Breaker Company, for over 50 years a leader in the circuit breaker and switchgear field, was vitally interested in mechanical rectification because of the attendant switching and protective problems involved, and also because mechanical rectifiers, being packaged equipments, fit in perfectly with I-T-E's high quality manufacturing techniques.

96.6% Efficiency at Buffalo

Three years ago I-T-E made available to industry the I-T-E Mechanical Rectifier. The first two units went into operation early in 1949 at the Buffalo, New York, plant of the Buffalo Electro-Chemical Company, Inc. Rated at 3500 amperes, the twin units carried 5000 amperes at 260 volts d-c—96.6 per cent efficiency. Since then, Buffalo Electro-Chemical has ordered five more Mechanical Rectifiers—to augment a modernization program.

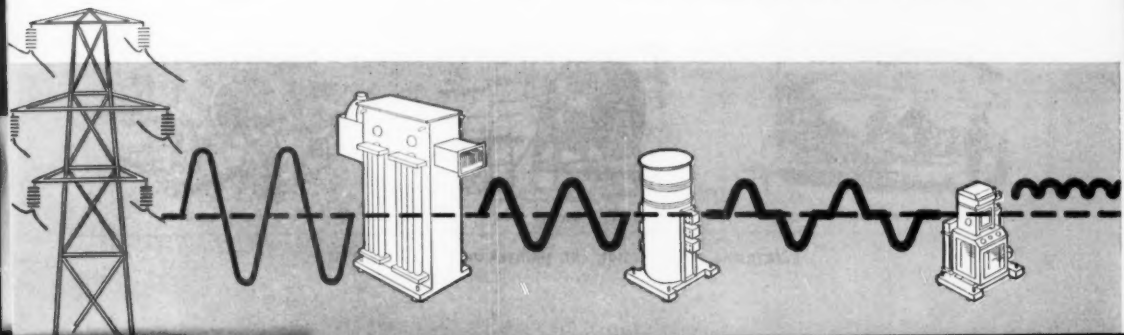
Numerous other industries in this country and abroad also have placed orders for I-T-E Mechanical Rectifiers.

You'll find complete technical and descriptive information on the I-T-E Mechanical Rectifier in Catalog 5106. Send for it today. I-T-E Circuit Breaker Company, 19th and Hamilton Streets, Philadelphia 30, Pa. Subsidiaries: Railway and Industrial Engineering Co., Greensburg, Pa., Eastern Power Devices, Ltd., Toronto, Canada.

MECHANICAL RECTIFICATION
becomes a practical means of power conversion for applications up to 10,000 amperes per unit in the 50 to 400 volt range at efficiencies of 96 per cent and over!

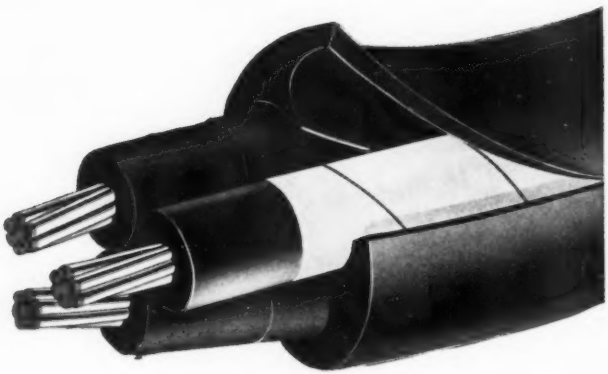
INCREASED OUTPUT
and reduced operating costs will benefit all users of low voltage direct current.

The I-T-E Company



DURASHEATH

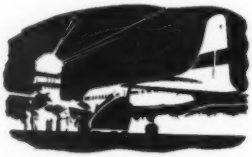
...the all-purpose cable



For city power and light systems

For rural power and light systems

For railroad signal systems



For airports,† mines, camps

For industrial power and light systems

You can recommend and install **DURASHEATH** for almost any service up to **5,000** volts

DURASHEATH* stubbornly resists electrolysis, corrosion, temperature extremes, cutting, abrasion, impact, flame, oil, grease, moisture and most soil acids and alkalies. Can be run overhead, in ducts, or buried underground—or all three in one continuous run. Flexible, easy to handle and install. For technical data, or for practical tips on where and how to suggest and install Durasheath to best advantage, consult your nearest Anaconda Sales Office or Distributor. Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York.

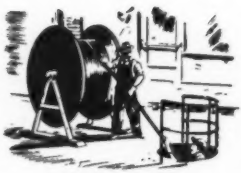
†When ordered to CAA Specification L-824 *Trademark

53-1552B

ANACONDA®

WIRE AND CABLE

String it overhead



Pull it through ducts

Bury it underground

ELECTRICAL CONSTRUCTION AND MAINTENANCE

50th Year —JULY • 1951

New Frontiers

IT IS THE CUSTOM, on reaching classic anniversaries, to engage in retrospect. In this, our fiftieth anniversary issue, we observe the custom in relatively slight degree, and then only for historical perspective. We serve a dynamic, growing industry concerned with today's achievement and tomorrow's challenge. We choose, therefore, to devote this special editorial effort to delineating the new frontiers of our industry and the directions in which they are moving.

FRONTIERS THEY ARE. As we look back with respectful humor upon the ways of our predecessors at the turn of the century, we honor them as pioneers. They and we have moved the frontier a long way forward with compelling creative force. But it is still a frontier, with vast unexplored areas out beyond. Here and there we can confidently chart probable areas of opportunity. But none of us can visualize fully the course of development over the next half century.

PRESENT SHORTAGES and substitutions of a war economy are momentary in the larger scale of industry progress. They hold back or speed up specific industry trends. They change markets. But the normal pattern of growth is quickly restored when the emergency passes. It is of the essence of the electrical industry that it serves a prosperous peacetime economy or the emergency production of mobilization with equal facility and with much the same materials, methods and skills.

AS A PROGRESS REPORT, the following pages deal with the practical frontiers of electrical construction, installation and maintenance. The choice of subject and emphasis is toward methods and materials which are characteristic of current progress. And forcasts are drawn conservatively on the basis of clearly evident trends.

WHAT LIES BEYOND the frontier? What form will wiring take to serve utilization matched to generation from atomic energy sources? Such questions concern us little. They are comfortably remote. They invite absorbing speculation. But clear vision of current progress and of near future needs is vitally essential to practical work today. Current plans, specifications and installations must serve predictable growth.

THE CURRENT METHODS and practices of our industry are the heritage of all of us. The pioneers of our time will carry them forward. We propose that those who look back on our efforts from the vantage point of another half century, though they may consider our methods quaintly elementary, will review a record of initiative, creative imagination, and sound industry progress.

William T. Stuart

SERVICE — Today as in 1901 — IS

In 1869 ... Elisha Gray and Enos N. Barton formed the partnership that eventually led to the organization of the Graybar Electric Company, Inc.

With the electrical era still in its infancy, the new company was limited to the sale of rudimentary telegraph supplies, fire alarm boxes, push buttons, relays, and similar gadgets that made use of this new unseen energy. Yet, by 1871, Gray and Barton had already established a reputation for efficient, progressive service to the rapidly growing electrical industry in Chicago – and, its staff had grown from an original 8 employees to the group pictured here.

Though the first Gray and Barton catalog listed fewer than 100 electrical supplies, Graybar catalogs and literature today cover over 100,000 different items made by more than 200 of the nation's leading manufacturers.

In 1891 ... an expanded catalog apologetically listed a *"greatly improved incandescent lighting system – the most perfect means of artificial illumination yet devised. Although inferior in economy, the incandescent light demonstrates daily its ability to compete successfully with gas."* The hydra-like fixture illustrated was considered both efficient and in good taste with the decor of the times.

Modern-day Graybar offers the most complete selection of lamps and lighting units available anywhere. Continued study of lighting units and lighting methods lets us help you plan up-to-the-minute systems of all types.

In 1898 ... this light electric motor–*"finished in enamel, brass-trimmed, and handsomely ornamented"*– was featured *"not as a mere toy to be run for amusement, but as a practical motor for operating light machinery."* Developing 1/12 horsepower and operating on from 1 to 6 dry cells, it was priced at $12.00.

Less ornate, but much more reliable, are the General Electric Tri-Clad motors now available through Graybar–motors carefully built to take a physical beating and yet deliver smooth, steady power *when* and *where* you need it.

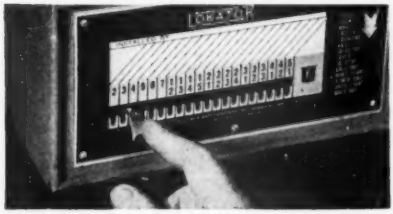
In 1901 ... these china and porcelain insulators for bare-wire installations still occupied a large section of the catalog. Contractors, however, had already begun to experiment with the more practical armored BX cable.

Graybar still strives to keep abreast of new developments in the fields of industrial, commercial, and residential wiring. As a result, many new systems have been quickly brought to the attention of contractors and industrials – enclosed bustribution systems, underfloor duct systems, trol-e-duct systems, and low voltage wiring. Similar developments in panel boards, switch boards, wires, cables, and fittings complete the wide line of construction and maintenance items distributed by Graybar.

still the big Graybar story

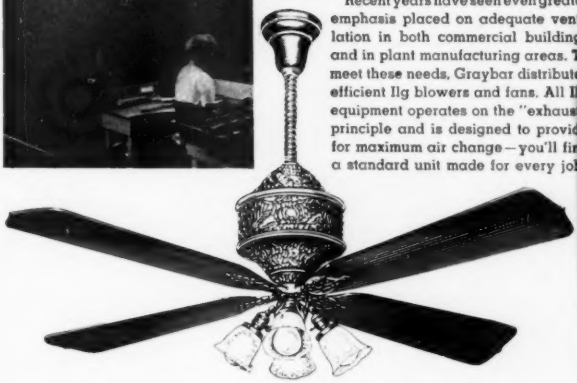
In 1904 . . . push buttons, buzzers, annunciators, gongs, and wheezy speaking tube systems were still standard. This return-call push, however, was the first step toward two-way electrical communication. A sounder indicated signals in one direction — a rapid humming noise indicated a signal sent in return.

Two-way inter-communication, today, is taken for granted. Just a flick of a lever and conversations can be held anywhere in an office or plant. Or, where preferred, you can install code-paging systems using buzzers, horns, musical notes, or silent flashing lights — all are available via Graybar.



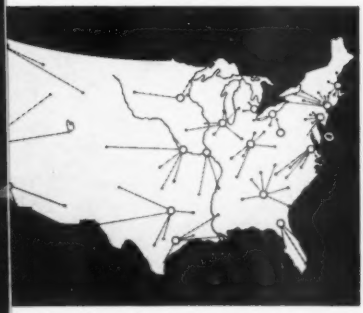
In 1908 . . this ornate ceiling fan was listed as the latest thing in office ventilation. Operating on 110, 220, or 500 volts d.c. the 60" blade featured 3-speed control. The detachable 4-light chandelier cluster provided an extra flourish for the drab offices of the period.

Recent years have seen even greater emphasis placed on adequate ventilation in both commercial buildings and in plant manufacturing areas. To meet these needs, Graybar distributes efficient Ilg blowers and fans. All Ilg equipment operates on the "exhaust" principle and is designed to provide for maximum air change — you'll find a standard unit made for every job.

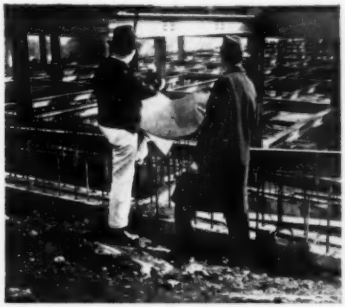


Today

. . . it pays to order all your electric requirements through your local Graybar office. Graybar has grown up with the electrical industry and will continue to keep step with its every advance. So, take advantage of the extra service and facilities Graybar offers you for more efficient job planning.



nation-wide warehouse system. A careful day-by-day inventory analysis helps us anticipate and forestall many local shortages before they become critical . . . permits us to shift emergency stocks to meet your requirements.



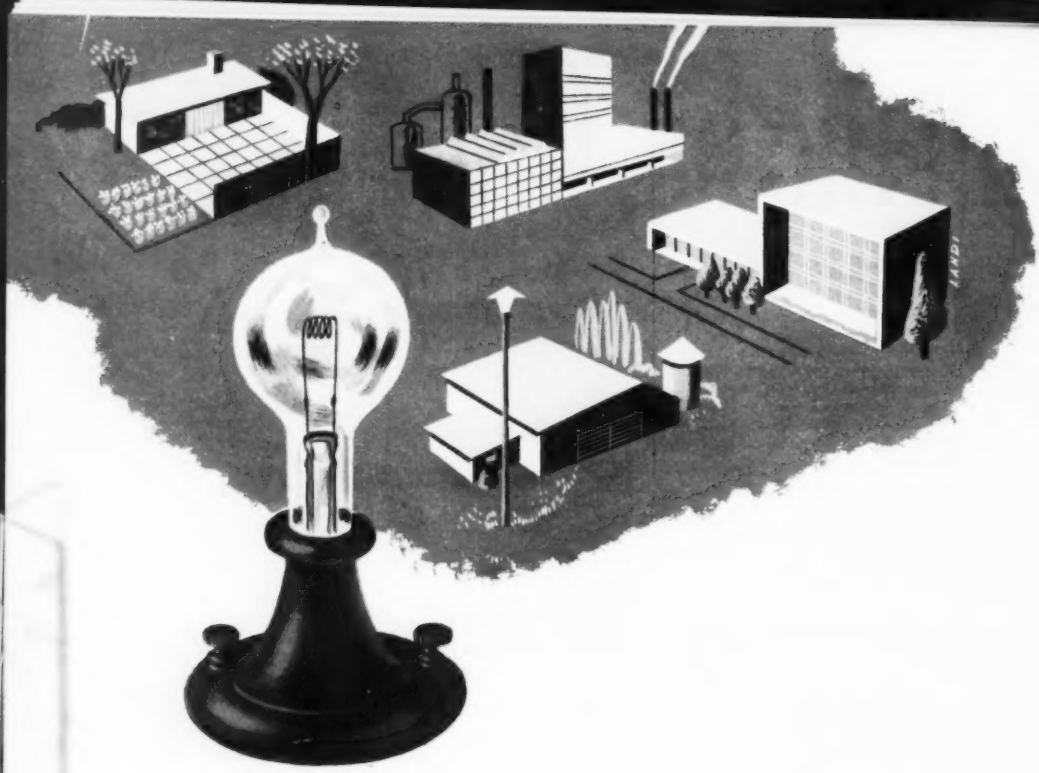
Local Graybar Representatives. Your near-by Graybar Representative knows electrical products . . . knows how they can best be used. You can rely on Graybar to furnish quotations and information on delivery conditions in your area.

The help of experienced Graybar Specialists. For assistance in solving out-of-the-ordinary problems or for help in the selection of alternate construction methods and materials, you'll find the services of a Graybar Specialist invaluable. 181-47

You can get EVERYTHING ELECTRICAL . . . via Graybar

IN OVER 100 PRINCIPAL CITIES

GRAYBAR ELECTRIC COMPANY, INC.
Executive Offices:
Graybar Building, New York 17, N. Y.



This Growing Industry

DOUBLING each ten years in service to the public, the electrical industry presents an expanding challenge to the vision, enthusiasm and courage of its people. Each milestone in its progress is a new frontier with ever wider horizons of potential growth and accomplishment.

With every forward step, many parts of a complex industry are faced with new markets and new opportunities. New responsibilities are incurred; new problems must be solved. But the genius of the industry, supported by great traditions, is instinctively forward looking and confidently able to meet the challenge.

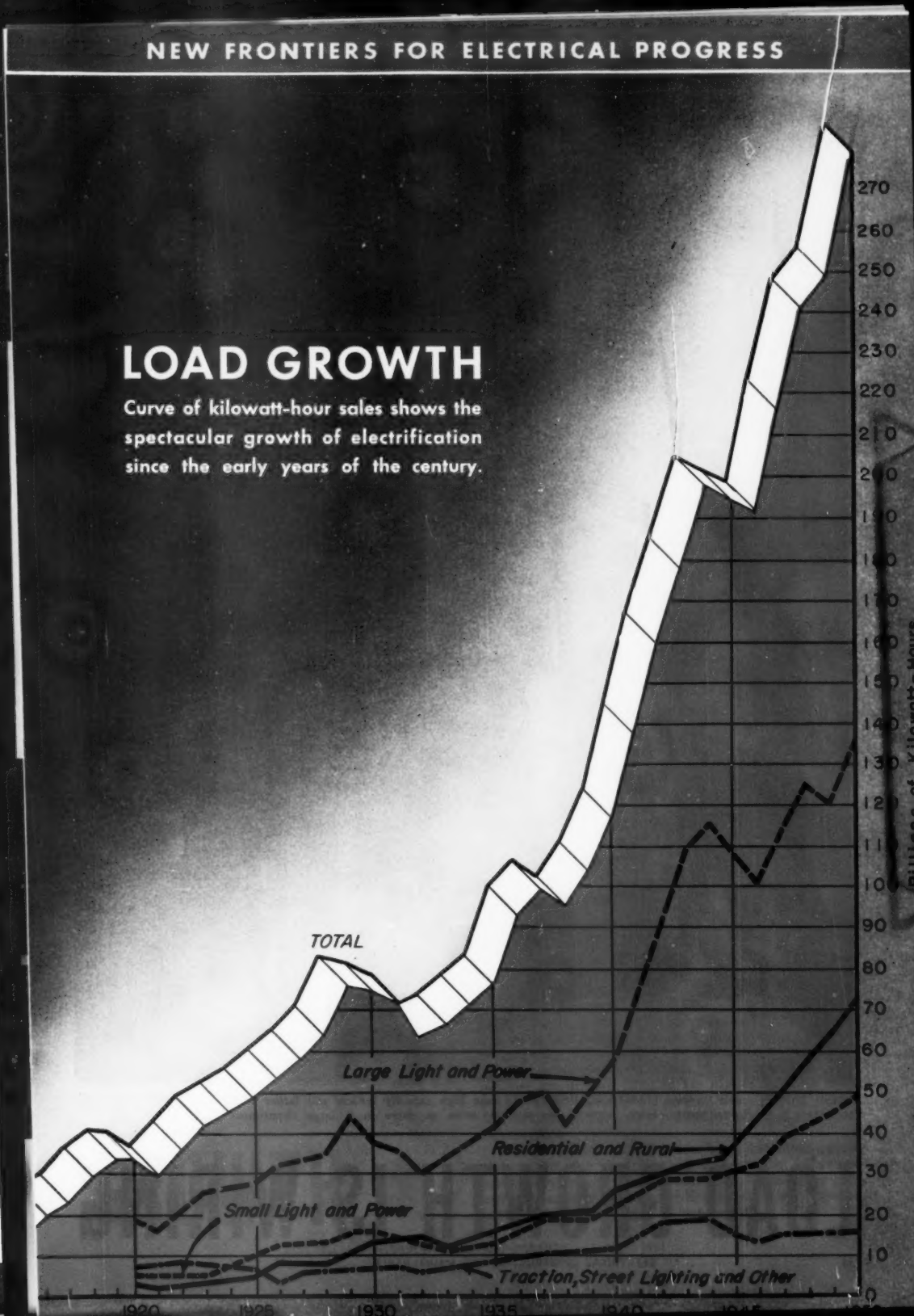
The growth of the electrical industry is spectacularly creative. More than any other industry it has built its own future. It does not only serve the needs and desires of its markets, it creates needs and desires where none existed before.

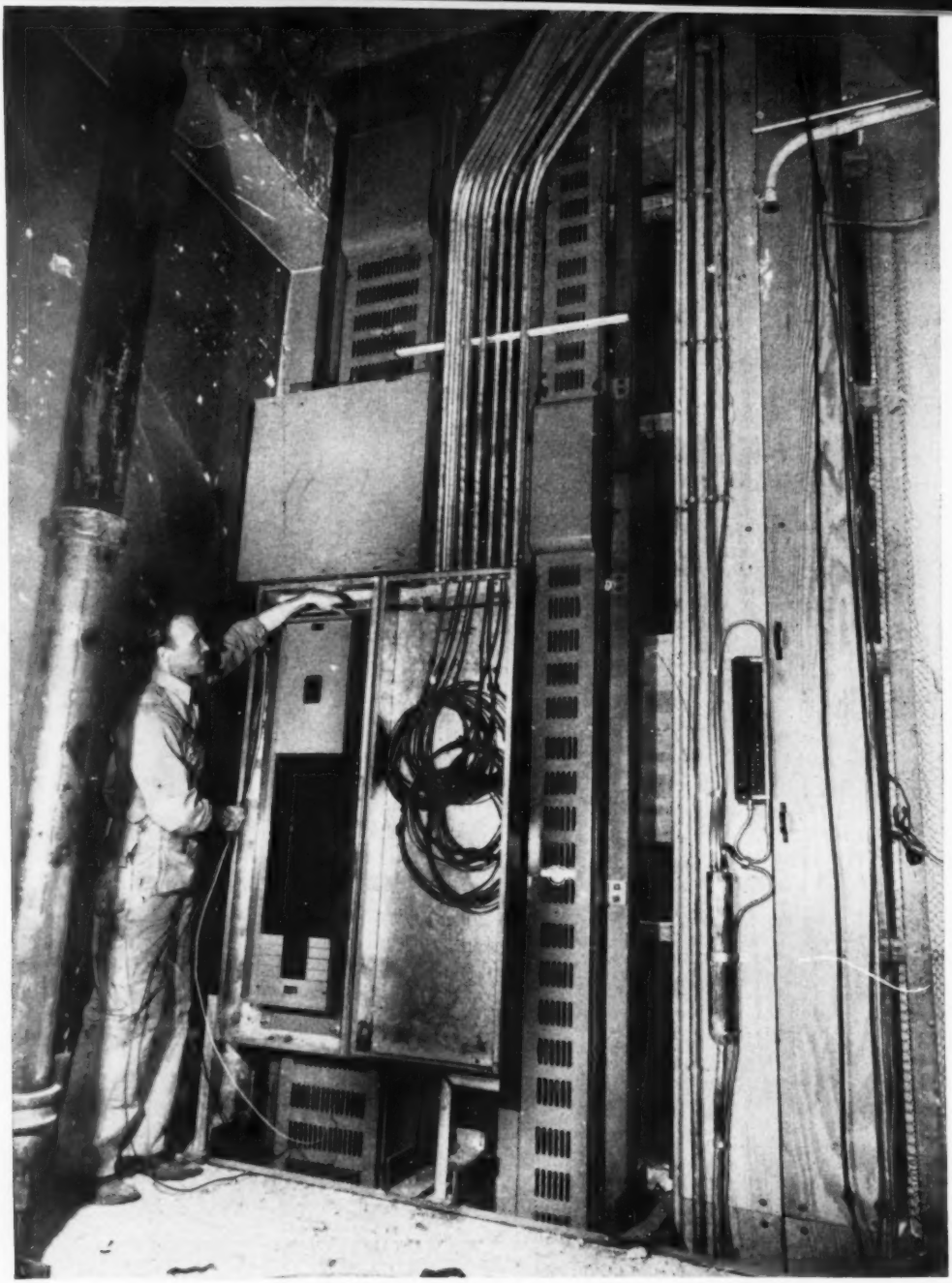
In power generation and distribution, in the application and connecting of the devices of utilization, in the manufacture and distribution of products, in the laboratories and in the skill of workmen, there is an interdependence of purpose and accomplishment. As individuals or groups move forward to greater achievement, they inspire related and corollary developments throughout the industry.

A fundamental index of electrical progress is contained in the statistics of generation. Electricity is made and used in an instant. The most remote application is reflected at the same moment on station instruments. Major areas of development in controls, electronics, communication and transportation are not indicated by comparable electrical utilization. So the information is not complete. But the generation index is still a useful one to visualize our growth and our progress potential.

Generation requires load. Loads must be served over distribution and wiring systems. And loads must consist of equipment, apparatus, lighting, heat and a myriad of specific utilization products.

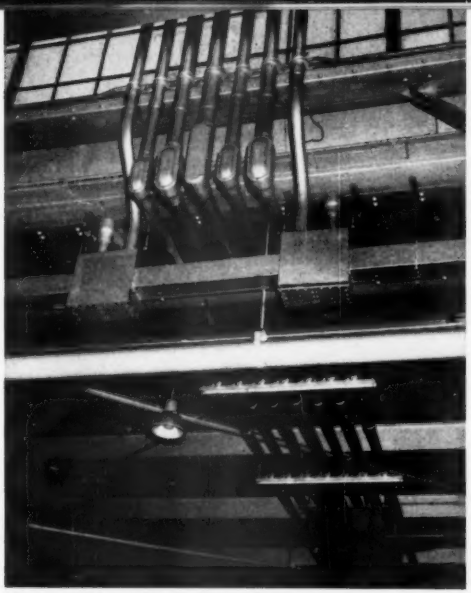
The frontiers of generation are those of utilization, of equipment design, of lighting application, of sales opportunities, of electrical manhours. They are the frontiers of management and of labor in utilities, manufacturing, distribution, construction and maintenance. And their destiny is linked by the characteristics of the great energy they harness and bring to the service of the public.


LOAD GROWTH
Curve of kilowatt-hour sales shows the spectacular growth of electrification since the early years of the century.
TOTAL
Large Light and Power
Residential and Rural
Small Light and Power
Traction, Street Lighting and Other
1920
1925
1930
1935
1940
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Billions of Kilowatt-Hours



GROWING LOAD REQUIREMENTS take high capacity feeders and larger distribution equipment. Here, vertical bus systems serve as risers in a large department store.

LOAD GROWTH IS WIRING



PIPE AND WIRE, special raceways, fittings and hangers grow in size and number as industrial utilization requirements expand for more kilowatts per man in production.

FLEXIBILITY of use location is provided by bus plugs and bus drop cables quickly moved to serve layout changes.

GROWTH

Kilowatts need wires. The advancing utilization curves disclose growing electrical needs served over growing electrical systems.

SINCE the early days of the century, electrical utilization, measured in kilowatt hours, has advanced at a rate roughly equivalent to doubling each 10 years. The future course shows no indication of slacking off from that pace. Events such as the depression and the postwar adjustment proved only momentary in effect on electrical progress.

Kilowatts must be dispersed over wiring systems, so, as a rough measure, the historical progress in kilowatt hour use gives a picture of the growth of wiring. The future course of wiring can likewise be discerned from the projection of generating capacity.

According to *Electrical World*, in 1955 generating plants contributing to the public supply of electricity will be capable of carrying a load of 102 million kilowatts. At a probable peak of 86 million kilowatts, 16 million kilowatts will be in reserve. The 1950 capability was 66.7 million kilowatts with a peak of 60.2 millions and a margin of 6.5 million kilowatts. From energy sales of 260 billion kilowatt hours in 1950, the same five year prediction comes to 377 billion kwhr. in 1955 representing a gain of over 36%.

Checked against another source, materials required for panelboards and bus systems, the increased requirements are in the order of double each nine years. Allowing for some extra acceleration in the use of such products, the rate of progress previously mentioned, doubling each ten years, appears to hold for wiring.

Ruling out the possibility of all-out war, which would invalidate any predictions we can make on the basis of the past, the pattern of energy sales in different fields may give a clue to wiring requirements as well.

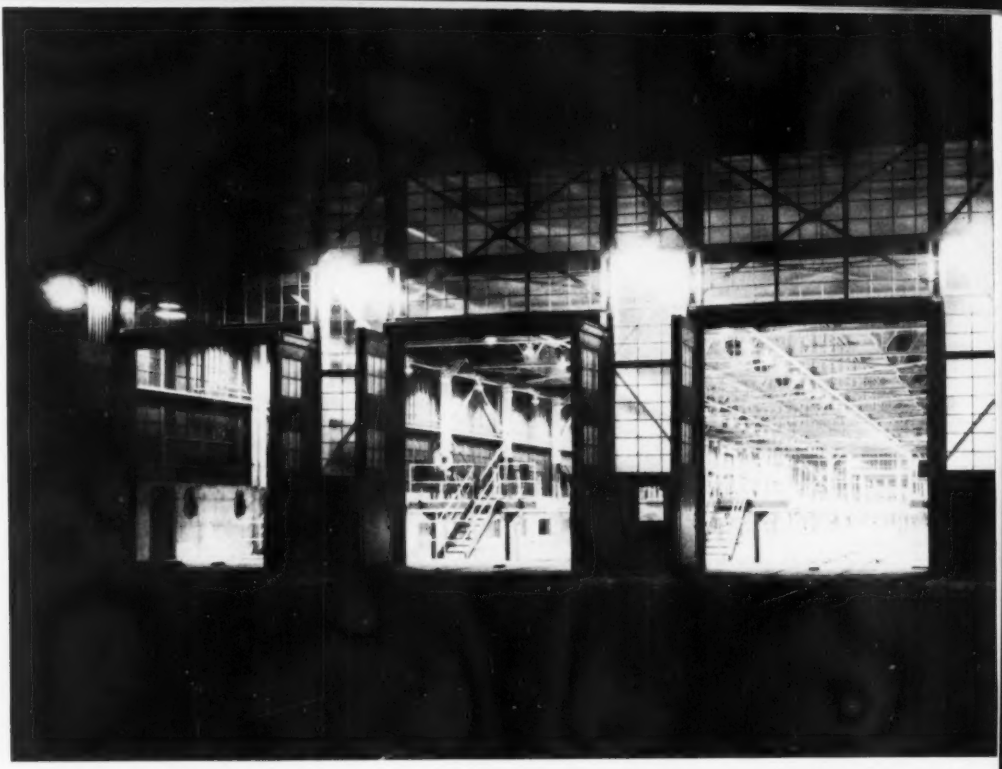
	Residential and Farm Sales (Millions of Kwhr)	Small Light and Power Sales (Millions of Kwhr)	Industrial and Other Sales (Millions of Kwhr)
1925...	5,930	8,850	28,296
1930...	12,492	13,944	40,148
1935...	15,109	13,588	40,864
1940...	25,309	22,373	59,557
1945...	37,852	30,438	107,490
1949...	65,523	46,262	120,766
1950...	73,900	50,050	138,350
1955...#	115,000	70,000	192,000

Estimated

These relationships are indicative but cannot be precise. Due to differing wiring requirements and practices, the residential requirements for wiring for additional kilowatt hours would be substantially less than industrial, with commercial and institutional somewhere in the middle.

The rapid growth in lighting loads of recent years can be safely projected considerably farther. There is no evidence that even the best of existing installations provide optimum conditions. Improvements in light sources are quickly adapted for higher lighting levels rather than economy in energy use. Wiring design for lighting is currently pegged at about 5 watts per square foot.

Electric space heating presents an enormous potential market for electrification and greatly influences wiring requirements where it is used. With larger generating capacity surplus predicted, active development of this kind of load may be not far off.



LIGHTING EQUIPMENT for diesel service shops include, 500 watt outside units. 500 watt low bay reflectors and

Equipment and Apparatus

FROM entrance switch to the last motor or lighting fixture, electrical industry growth is marked by a succession of developments, each inspiring others without limit. The evolution from line shaft to individual driver created a need for many special purpose motors. Individual switching led logically to magnetic switching, to many varieties of control and eventually to automatic operation. Enclosed switchgear and the askeral filled and air cooled transformer which required no special protection, became the power center which can be placed to best advantage in the middle of industrial load requirements.

Such developments are fluid. They are constantly in process. Often activities wholly foreign to the electrical industry open wide a field for some apparatus or process. Modern detergents greatly helped the electric dishwasher. New finishes expanded the usefulness of infrared drying. The exact precision of electronic control is already ahead of the development of industrial processes which can use it to the fullest advantage in industrial applications.

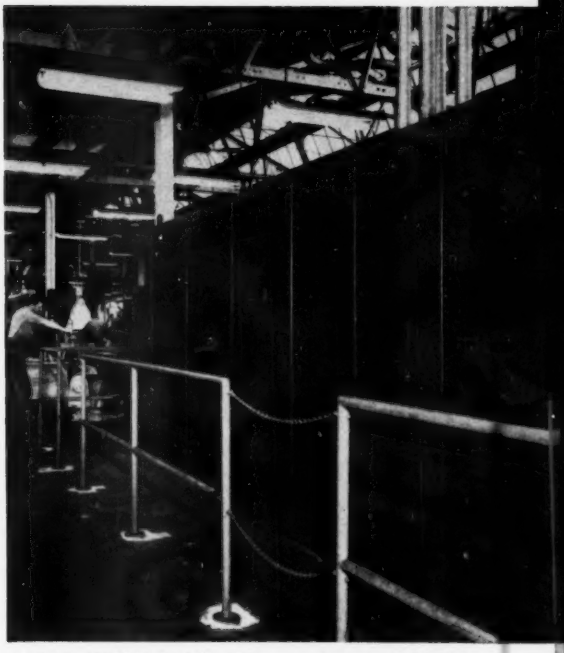
Important frontier developments include the recent studies in totally enclosed switchgear for high voltages and heavy current application. The modern switchboard bears little resemblance to those of only a few years ago. It is assembled from functional cubicles, matched in appearance, totally enclosed and free standing. They can be installed safely without additional enclosures or special protection other than that necessary to prevent unauthorized operation. Standardized units make possible a great variety of assemblies from a few basic elements.

Transformer banks in enclosures that match and line up with switchgear enclosures provide full substation operation.

Dry type transformers, which can be located without regard to isolation or special enclosures, have influenced many other kinds of apparatus. The many advantages of 440 volt power equipment do not extend to lighting where 120 volt supply is required. With transformer installations to reduce power voltage to lighting requirements, either or both voltages can be made readily available with the further advantage of lower power losses as a result of higher voltage distribution.

Most widely used motor for constant speed industrial application is the three phase squirrel cage induction

1000 watt high bay reflectors.



POWER CENTER for industrial power circuits contains high voltage transformers and utilization voltage switchgear.

New developments in equipment and apparatus constantly influence wiring designs and system use.

motor. Conventional voltages are 208, 220, 440, 550 and 2200 volts, with trends indicating increased use at the 440 volt level in new installations. Conventional enclosures are open, splashproof and fan cooled totally enclosed. Preference trends are toward the totally enclosed types.

Where speed variations, heavier starting torque and lower starting currents are needed, the wound rotor motor is widely used. For low speed application, the gearmotor, a high speed motor operating through a gear train, gives economical and efficient operation.

For loads of 20 hp. and over, the use of synchronous motors should be considered. They offer advantages of constant speed at high efficiency with the further ability to correct power factor. The dual function of carrying a load and at the same time raising power factor is particularly useful in plant areas where induction motors or other relatively low power factor equipment is in operation.

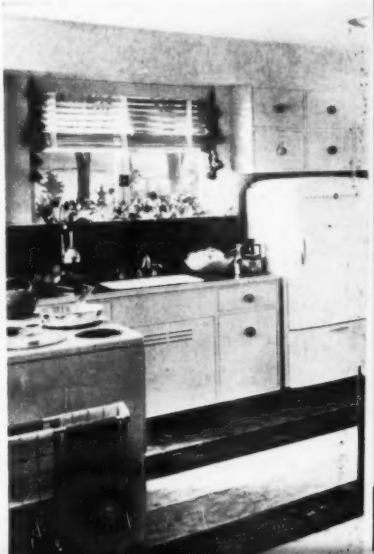
Specially designed and tested motors providing exceptionally quiet operation are applicable to many installations where it is necessary to avoid objectionable noise.

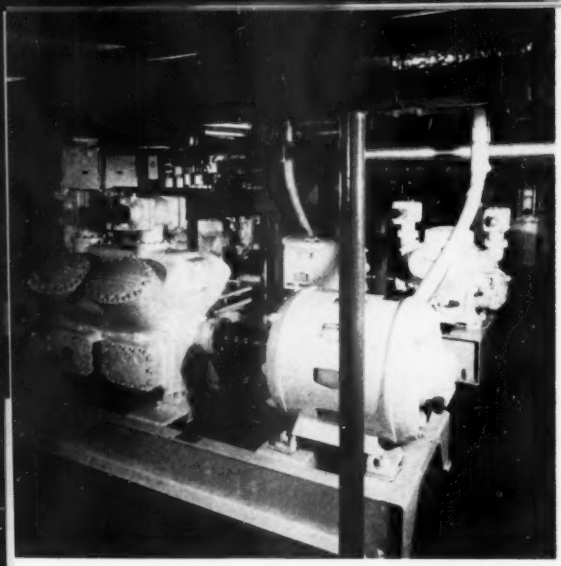
HIGH VOLTAGE outdoor enclosed switchgear installation at a Boston manufacturing plant. Units at right contain metering facilities and incoming feeder disconnects. Units at left contain interrupter switches and power fuses for load circuits.

THIS GROWING INDUSTRY *(continued)*

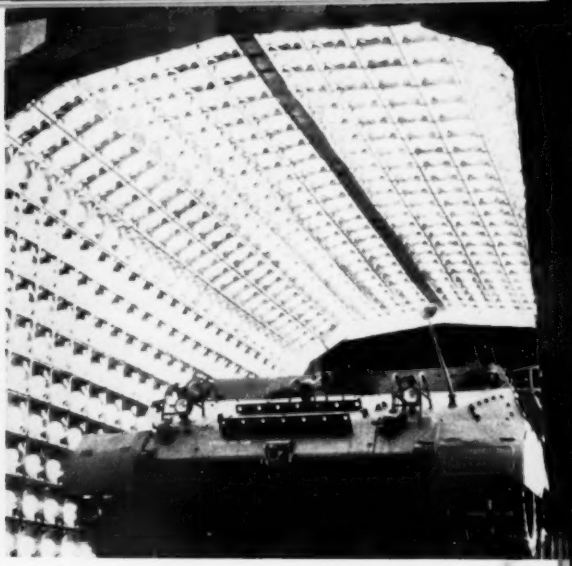
PROCESS CONTROLS involving elaborate instrumentation are increasingly familiar equipment in modern industrial plants. Installations involve extensive electrical work. Here operations of test engineer are controlled and recorded from two control rooms. The area is served by special ventilating systems and recessed lighting in acoustical ceiling.

ELECTRONIC CONTROLS provide precise adjustment and close control of operating speeds on critical processes. Here three thymatrol panels and their anode transformers operate bakery cooler, stacker and packing table drives. The motor is a 7½ horsepower gearmotor.



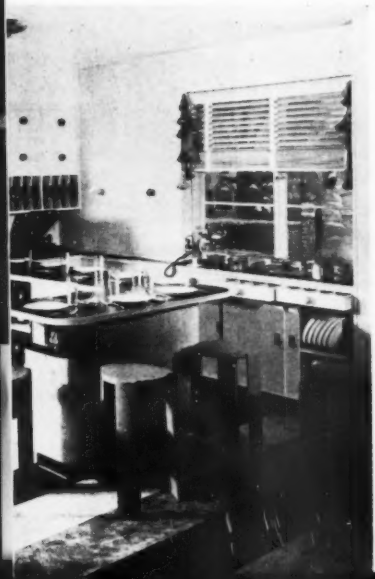


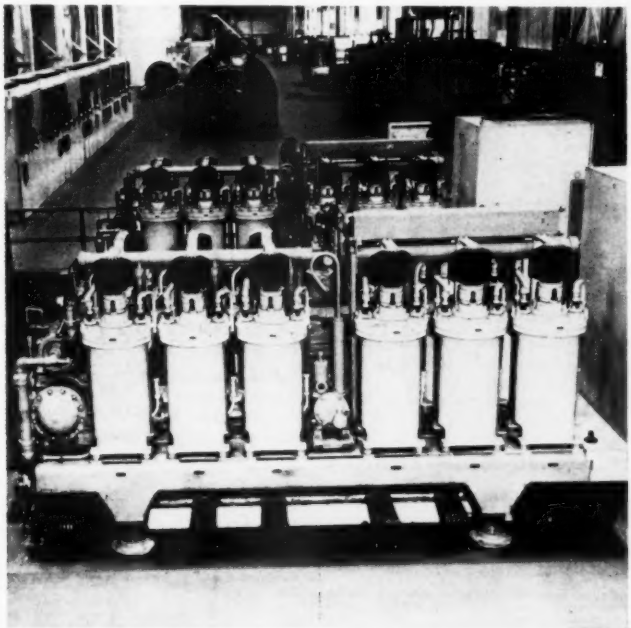
AIR CONDITIONING takes heavy motor equipment and precise controls requiring long periods of continuous operation. Pictured is an installation of 50 hp. and 75 hp. direct drive motors with increment type starters operating air conditioning compressors in a cafeteria.



ELECTRIC HEATING for comfort or industrial processing can be provided with a great variety of specialized equipment for which there are rapidly advancing opportunities for effective and economical application. Here a tank gets a corrosion resistant finish baked by many kilowatts of infrared lamps.

ELECTRIC LIVING, modern home appliances and lighting are among the most significant symbols of the present era. Electric wiring systems for residences are greatly influenced by new appliances and new methods of lighting. But even the very "modern" electrical installation of today will be outmoded by the continued advance in electrifying the home for modern living.





RECTIFICATION provides d-c for industrial processes from a-c sources. Motor generators, rotary converters, dry type, mechanical, electronic, and mercury arc rectifiers are available to adapt to any requirements. Illustrated are two 1500 kw. rectifier units in a steel plant.

New developments in industrial lighting

General Electric reports on five years' progress toward more production, fewer accidents, less spoilage, less fatigue

Industrial lighting has made many major advances in recent years. Check the items listed below and ask yourself how much you know about these new developments in factory lighting . . . all of them have come to the fore in the past five years.

1. SLIMLINE FLUORESCENT

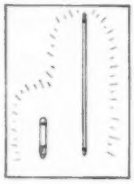
This is fluorescent lighting with long, thin tubes up to eight feet long. Chief advantages for industry are simple and very easy maintenance, high efficiency.

2. R-52 LAMPS

These are 500 and 750 watt lamps that have built-in reflectors. Excellent for high-bay areas, such as foundries, and other areas where it is difficult to clean lighting equipment.

3. IMPROVED MERCURY LAMPS

The 3000 watt mercury lamp produces light at lowest overall cost—an enormous amount of light from one course. General Electric's new 400-watt EH-1 lamp gives 25% more light, important in saving energy and materials.

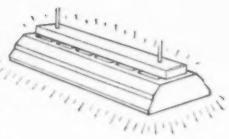


4. PLANNED MAINTENANCE

In many cases, regular cleaning, plus replacement of lamps in groups on a regular schedule, produces important savings in cost of light.

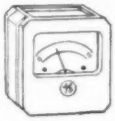
5. BETTER LIGHT DISTRIBUTION AND BETTER SHIELDING

New fluorescent fixtures, available from a number of manufacturers, direct some of the light upward, to avoid undesirable extremes of contrast between work and surroundings. And better shielding helps reduce uncomfortable glare.



6. HIGHER LIGHTING LEVELS

Not so many years ago, fifty foot-candles seemed like a high level in industry. But experience indicates this should be a *minimum* in most types of work.



7. SIMPLIFIED FLUORESCENT LINE

General Electric's line of four (4) white fluorescent lamps ends earlier confusion about which color of white fluorescent to buy. Use *Standard* White (cool or warm) where efficiency is most important; use *DeLuxe* White (cool or warm) where completely satisfactory color rendition is required.

Can we help you with your problems on production lighting? Call your nearest G-E lamp office. Or see your G-E lamp supplier or your local electric service company.

For a free copy of a new illustrated bulletin "Planned Lighting for Industry" write General Electric, Div. 166-EC-7, Nela Park, Cleveland 12, Ohio.

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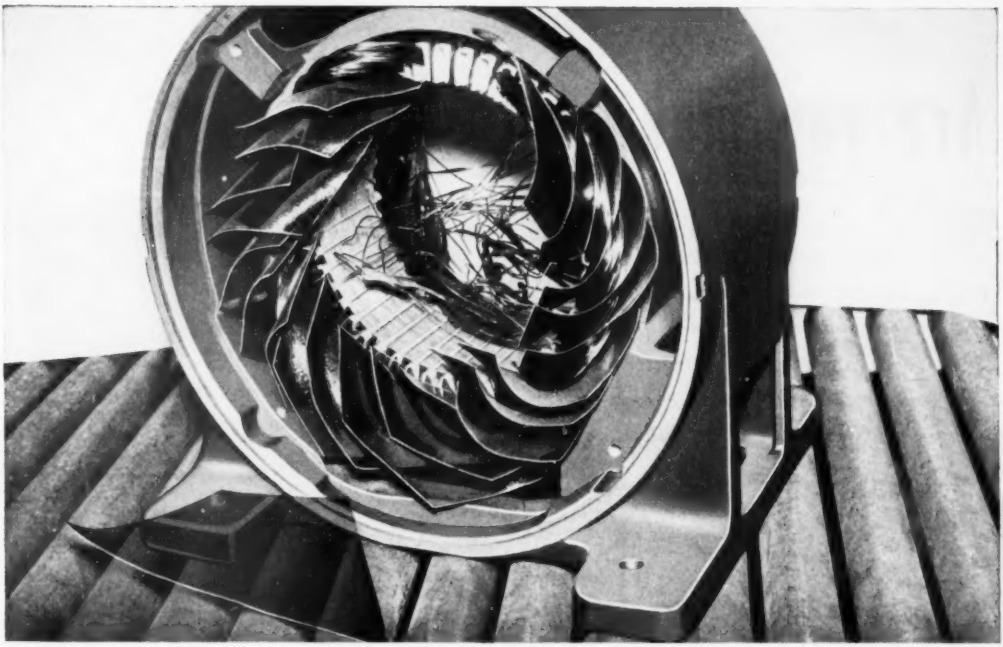

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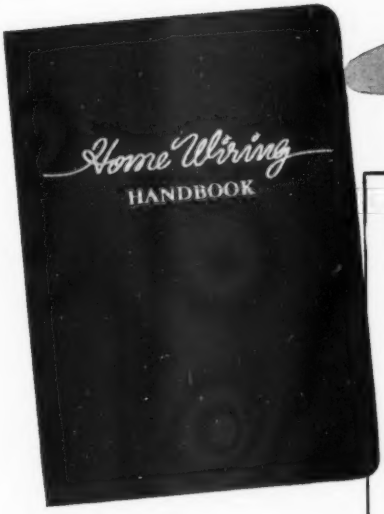
HOME WIRING HANDBOOK



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- Electrical Equipment for the Home
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- Electrical Outlets
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- Electrical Control Centers, Feeders and Service Entrance
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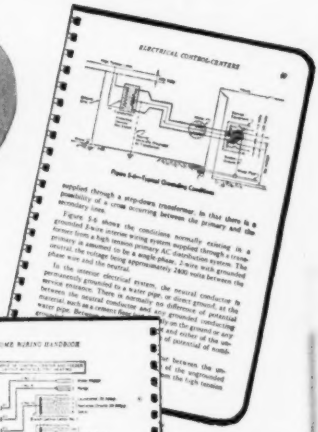
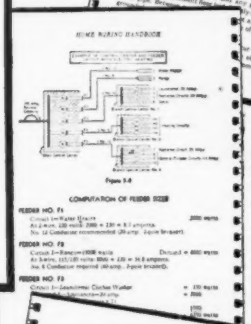
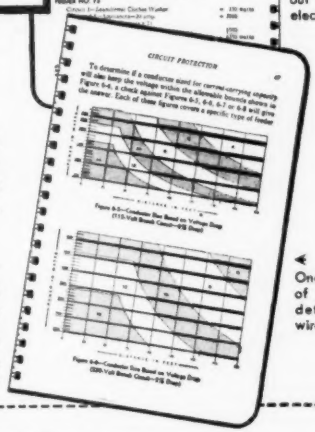
- Communication Systems
- Suggested Specification for Single Family Dwellings
- Estimating Electrical Costs
- Building Design and Construction Terms
- Miscellaneous Charts and Tables
- Dimensional and Other Data on Electrical Products



▲ Diagram showing electrical service between high-tension line and load center in home.



◀ Example of control center and feeder layout for a completely electrified home.



◀ One of several charts of voltage drop for determining size of wire required.

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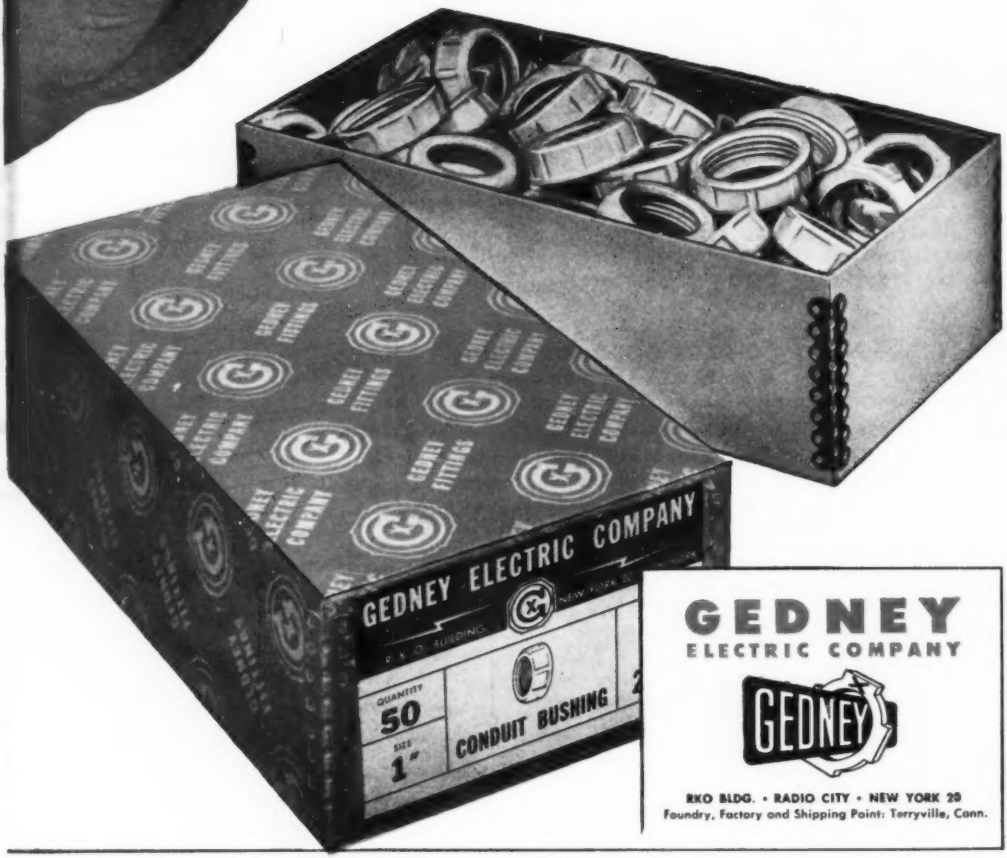

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How NECA has helped its members

The prime responsibility of NECA to its members is to carry on activities that will bring them more profitable business. Electrical contractors are small business men. NECA's programs are designed specifically to assist its members by providing essential management services big businesses can conduct for themselves but which can only be provided small business men by collective action through their trade associations. Such activities include labor relations, information, research and education, public relations, codes and standards, apprenticeship and training, and relations with government. NECA provides all of these services to its members.

DEVELOPMENT

How NECA has helped the industry

The basic function of a trade association is to provide for its industry the apparatus for industrial self-help and expression. Working through NECA, electrical contractors have many times successfully preserved the identity of their specialty, and thus protected their own businesses. Had there been no NECA there would be no separate, prosperous specialty electrical contracting industry today. Working through NECA, the electrical contractors have raised the standard of their operations from a pliers and screw-driver trade to a business conducted in an ethical, efficient and professional manner.

There's a continuous job to be done

Progress means change. Particularly is this true of Electrical Progress. Viewed in the perspective of what is to come, it can be said that NECA has only started to work. Constant attention to industry problems and alertness to development is the price of admission to progress. The big job in the years immediately ahead is to forge a practical mold of inter-dependent thought and action in the Electrical Industry. It is a challenge NECA eagerly accepts.

★

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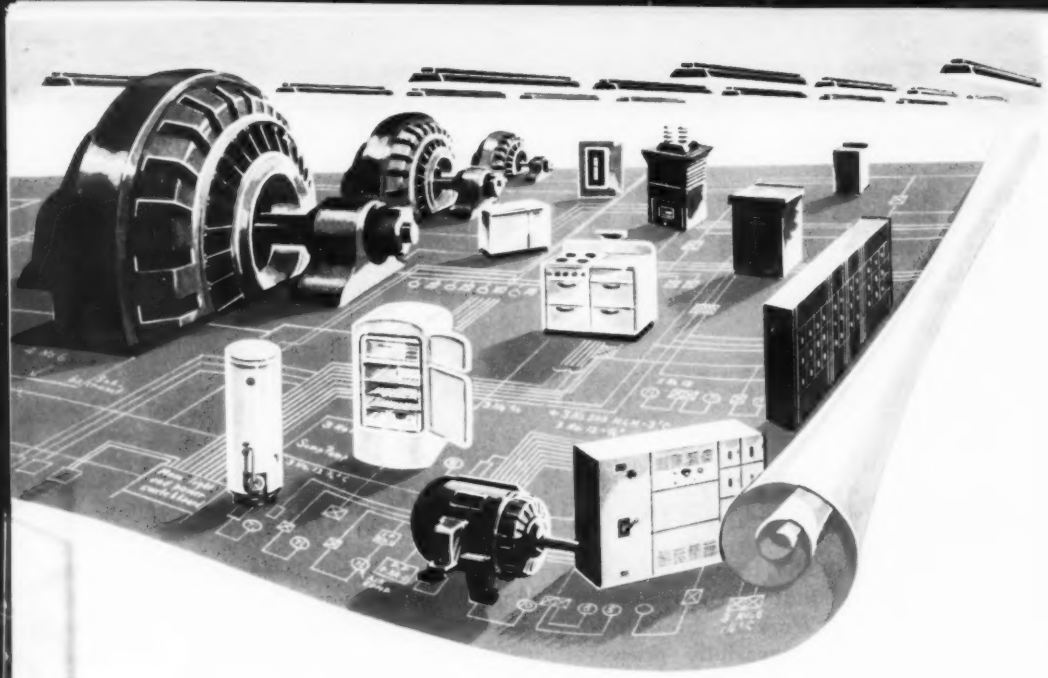


Looking Ahead in Wiring Design

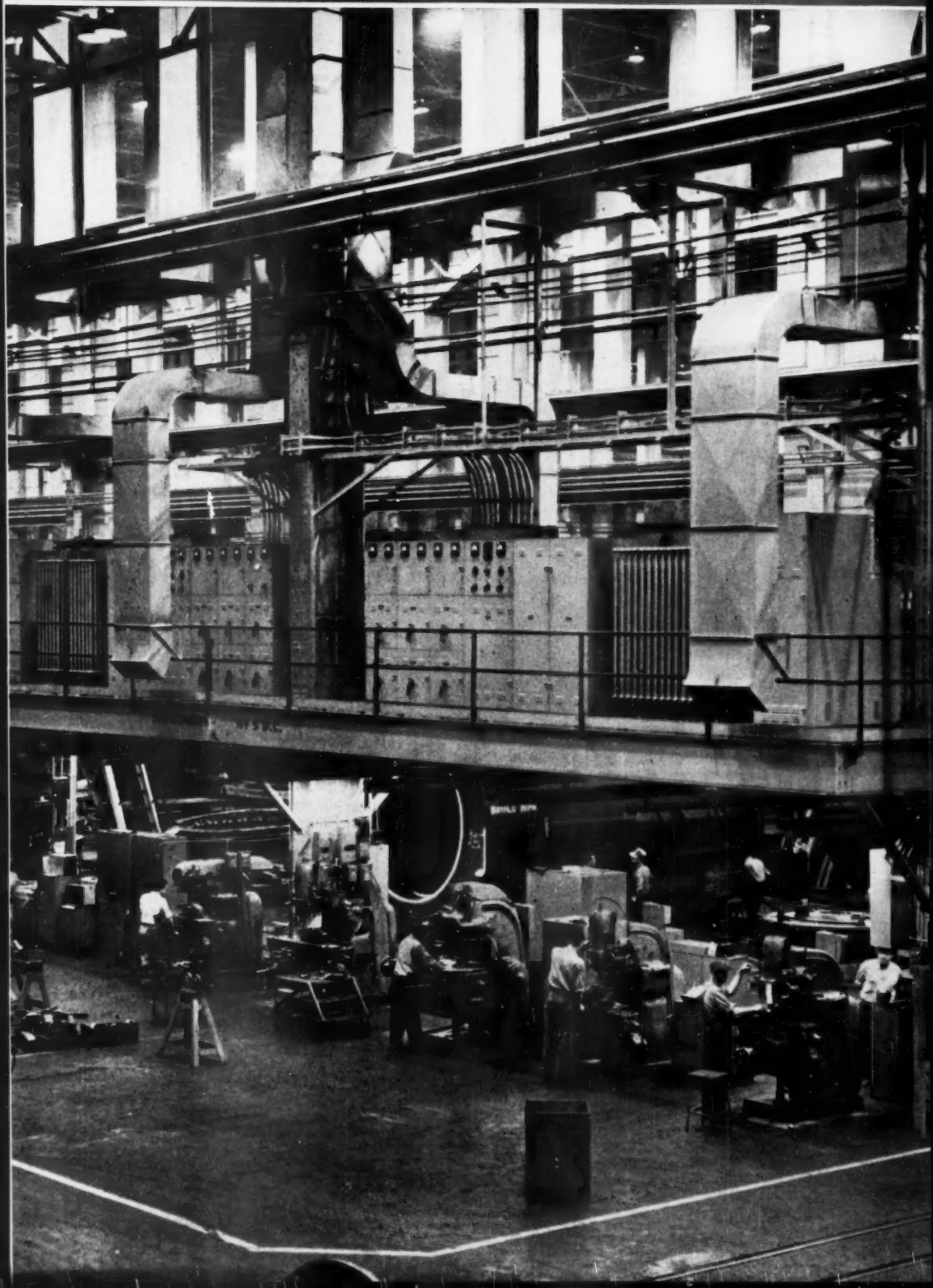
WIRING system design developments are paced by advancing utilization needs and by considerations of adequacy, accessibility and control. Safety, service, reliability, and provisions to meet changing needs are also factors of varying importance in individual applications.

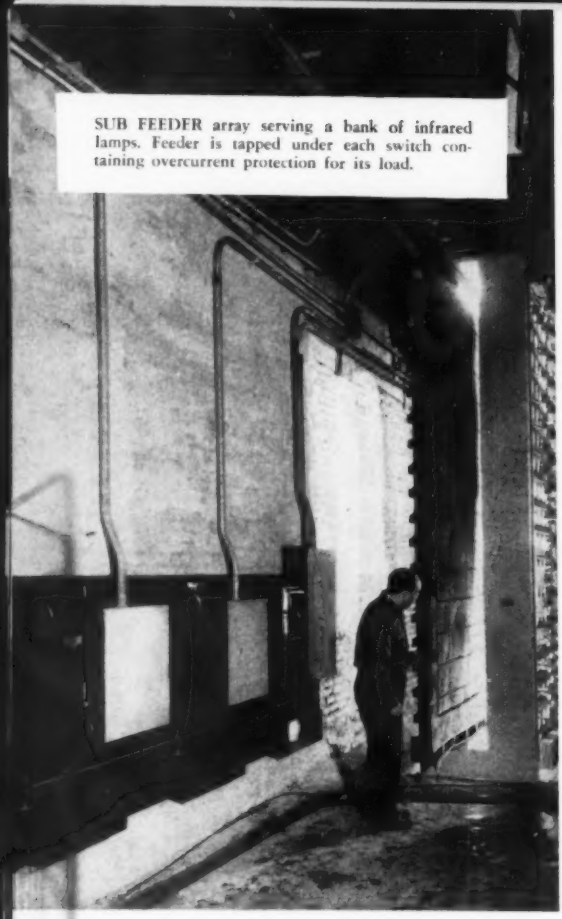
Mid-century frontier developments are marked by a wide choice of voltages, systems, methods and materials and a free use of equipment to change the characteristics of delivered energy to fit distribution and utilization requirements.

At the voltage extremes are 13,000 volt primary systems distributing energy to load center substations and plating circuits of only a few volts. From 60 cycle, power conversion equipment produces direct current, high cycle power and high frequency energy at desired utilization voltage. Conversion equipment may be located at the point of utilization or at a load center distributing its energy of special characteristics over a separate distribution system.

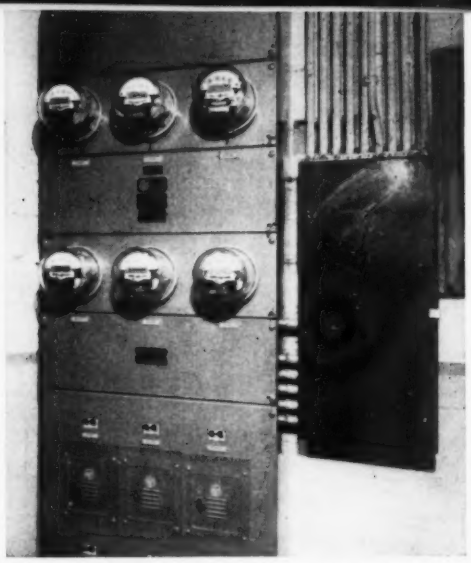
System design draws upon an increasing number of wiring methods, and devices for control and accessibility. Trends are toward modular dimensions and assemblies of uniform and interchangeable units in panels and switchboards and conductor insulations.

Frontier wiring design is marked by the variety of methods employed more than by strong trends toward one or another wiring material or distribution system. This fluidity of selection is a healthy characteristic of the great growth potential in the industry.





SUB FEEDER array serving a bank of infrared lamps. Feeder is tapped under each switch containing overcurrent protection for its load.



ENTRANCE ASSEMBLY for a six tenant office building. All equipment is built into a common enclosure. Branch circuit sections are standard circuit breaker panelboards set flush.

MODERN

CURRENT practice in the design and installation of distribution systems which would indicate the course of future trend shows great diversity of materials and methods, while at the same time tending to standardize on certain fundamentals. For minimum design considerations and for many details of installation, the National Electrical Code compels essential uniformity. Preferred voltages are rapidly becoming accepted as practical standards impelled by the greater availability of apparatus and equipment designed for these voltages. Industry standards also provide a substantial degree of uniformity in performance characteristics, dimensions, etc., of equivalent products.

The most spectacular advances in interior distribution have occurred in recent years, notably the enclosed busway and the load center substation. Their rapid adoption and continued expansion in industry acceptance indicate a lively trend toward the kind of engineering advantages inherent in their use.

Growing load requirements have greatly increased the size and capacity of service entrance equipment in terms of the type of occupancy and area of the building. This trend is still sharply upward, and in all probability present practices will be altered considerably in the years ahead.

The present Code rule permitting up to six disconnecting and associated overcurrent protective devices on a service entrance is tending to eliminate the main switch on many types of jobs. With panels of appropriate construction, eight and potentially twelve single pole circuits can be so operated as to come within the rule for service entrance equipment.

For heavier loads, the use of grouped enclosed switches or circuit breakers is common practice. These often operate as the distribution panel as well as service switches feeding directly to branch circuit panelboards. On large entrances or where higher voltages are involved, the single main switch or breaker still predominates with main feeders serving a distribution panel on switchboard.

Future trends in service entrance equipment are likely to include unit construction in which all the equipment is consolidated within a single enclosure or matched modular enclosures.

Wiring Systems

Conduit and wire systems constitute the most used method of distribution in industrial, commercial and institutional buildings. For distribution systems, rigid conduit provides excellent mechanical protection to the conductors, a heavy enclosure for possible faults, and a low resistance path to ground for fault currents to operate circuit protective devices.

Although one of the oldest wiring raceways, conduit installations have been improved and speeded by better

SELF SUPPORTING aerial cable is neoprene sheathed twisted conductors bound to a steel messenger cable. Strong construction permits long spans, occupies little space.

CABLE TROUGHS are ventilated wireways with fittings designed for on-the-job assembly. Illustrated is a section carrying control cables in a utility plant.

DISTRIBUTION SYSTEMS

Distribution systems extend the electrical characteristics of the power supply to branch circuit panels, modifying or refining as required for utilization needs.

corrosion resistance in coatings, better bending qualities, protection of threads in transit and handling, and many power operated tools for cutting, threading, bending and fastening.

Conduit fill follows the rules of the Code in average applications or the 40% rule where the Code does not designate specific sizes. For special cables, such as those used on high voltage circuits, one size over that used for conventional building wires of equivalent outside diameter is a common current practice. Another common variant from the Code tables is a minimum of ¾ inch for all light or power wiring.

Electric metallic tubing or "thin wall" is gaining rapidly for feeder circuits requiring 2 inch or smaller conduit. It offers light weight, with easier handling, cutting and bending.

Some recent projects have made extensive use of interlocked armored cable in the larger sizes for feeders. The combination of flexibility and protection from mechanical injury offers notable advantages for many types of projects.

A wider variety of special raceways is available than ever before, and there is every reason to assume that such developments will continue to meet wiring needs.

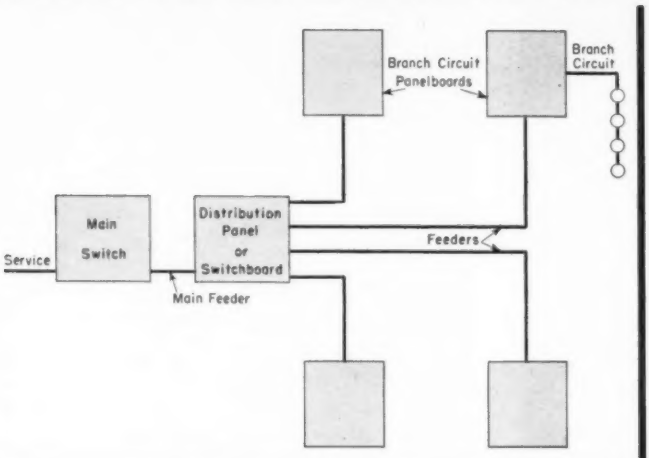
Open wiring on insulators, the oldest method of wiring, is still used extensively for distribution where the conductors can be installed well away from probable mechanical injury. Open installation also allows a considerable gain in conductor current capacity, at the cost, however, of increased voltage drop. A new variation of this method making important gains is a preassembled self-supporting aerial cable. Conductors are compactly twisted together and bound to a steel messenger cable.

Since electric energy on constant voltage systems will continue to flow to destruction, overcurrent protection is of prime importance in system design.

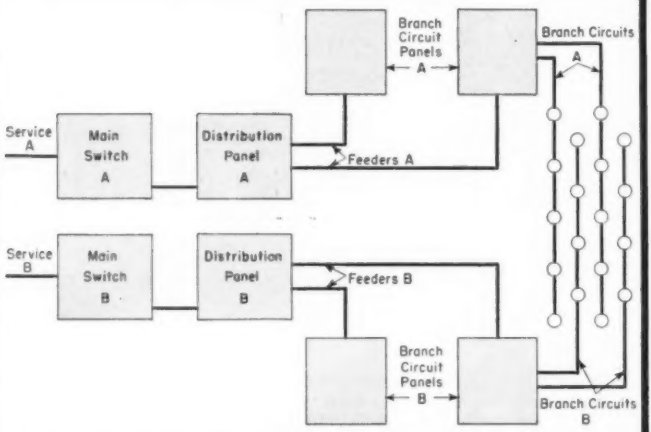
Good system design tends toward reducing voltage losses and improving regulation. Large conductors, low reactance bus, higher voltages and power factor correction, all tend to increase the amount of energy that can flow into a "short circuit". Thus, a consideration of growing importance in wiring design is the interrupting capacity of overcurrent protective devices.

For fused equipment, new lines of high interrupting capacity fuses have been designed to meet requirements, particularly in industry, where short circuit currents in the area of 100,000 amperes can occur.

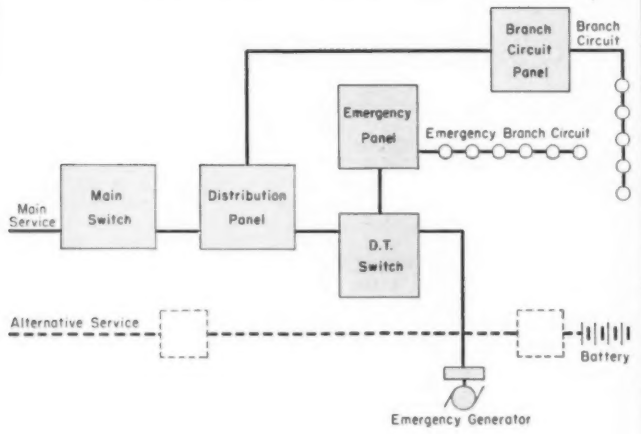
Circuit breaker panels have been developing in the direction of standardized enclosures and bus, with interchangeable branch circuit elements providing a large variety of panelboards from only a few quickly assembled parts. This is a significant developent which can be carried logically far beyond the equipment now available and considerably more progress in this direction can be expected.



A—Simple radial systems are applicable to most installations. Service at utilization voltage enters the main service switch or circuit breaker. There may be as many as six service switches. On smaller projects the service switch or switches perform the function of the distribution panel and feeders extend directly to branch circuit panels. Most common voltage for service and distribution are 208/120 volt 3 phase 4 wire and 240/120 volt single phase three wire. Where separate light and power services are provided, two separate systems are used, usually 240/120 volt 3 wire for lighting and 240 volt 3 phase, 3 wire for power.

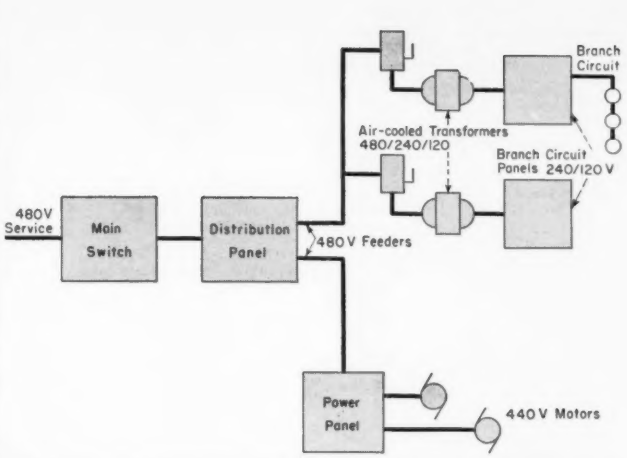


B—An important variation of the simple radial system is the dual distribution system. Here, two services feed essentially duplicate but entirely separate distribution systems so that even a major system failure can affect only one system. Branch circuits serve duplicate equipment and alternate rows of lighting. Because such systems are virtually panic-proof they are particularly adaptable to large stores and places of public assembly.

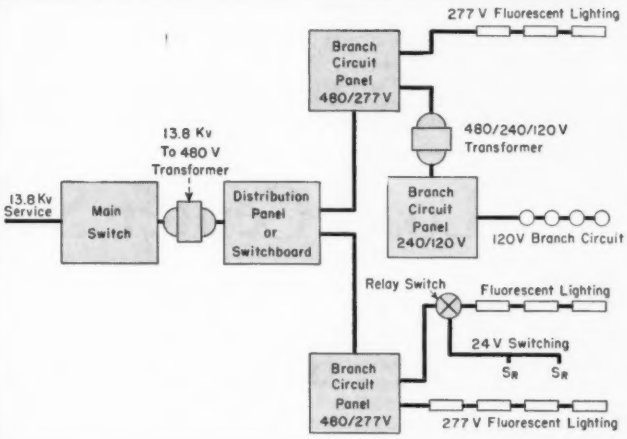


C—Many types of occupancies require provisions for emergency lighting or power if main supply sources fail. Three basic methods are used: 1) a separate service not associated with the main supply, 2) a local generating plant, usually gasoline driven, with either automatic or manual starting features and 3) a local battery supply. Emergency circuits to be served are fed from a separate panel or panels connected normally through a double pole switch to the main supply. Upon supply failure, the double pole switch connects automatically to the alternate or local supply source.

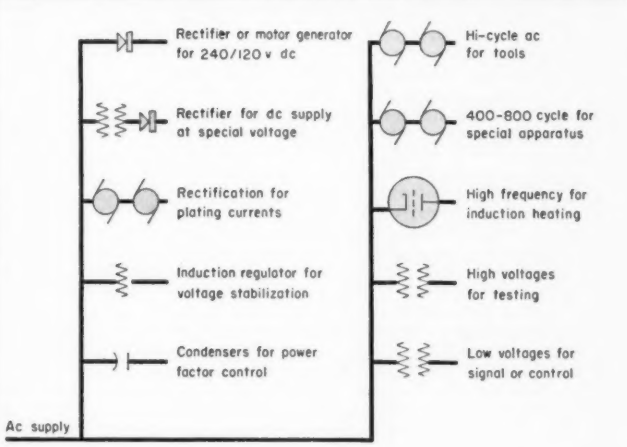
D—Where 480 volts is available, this type of system is gaining rapidly in popularity not only for industrial but also for commercial buildings. Its use has been greatly stimulated by the development of bus feeders and air cooled transformers. Here 480 volt three phase power is distributed and used directly for power. Air cooled transformers at load centers drop the voltage to 240/120 for lighting and small power requirements.



E—A new development for industrial and commercial buildings with large fluorescent lighting loads employs a high voltage service and load center substations reducing to 480/277 volt 3 phase 4 wire for branch circuit distribution. Lighting equipment designed for 277 volts is operated at the distribution voltage. For plug receptacles, 120 volt lighting equipment and small power, the voltage is reduced through air cooled transformers. A unique feature of this system is the use of 24 volt relay switching for the local or remote operation of the fluorescent lighting.



F—Examples of distribution modification or refinement for special purposes. Rectification, frequency changing, or transformation may be provided by central equipment and the proceeds fed to extensive distribution systems; or the apparatus may be located near, or integral with, equipment requiring voltages and currents of special characteristics.


Rectifier or motor generator for 240/120 v dc
Rectifier for dc supply at special voltage
Rectification for plating currents
Induction regulator for voltage stabilization
Condensers for power factor control
Ac supply
Hi-cycle ac for tools
400-800 cycle for special apparatus
High frequency for induction heating
High voltages for testing
Low voltages for signal or control

Voltage Designation of Electrical Systems and Related Equipment Voltage Ratings

Note the preferred voltages for new installations.

Nominal System Voltage	Generator Rated Voltage	Transformer Secondary Rated Voltage	Transformer Primary Rated Voltage	Motor Rated Voltage	Lamp Rated Voltage
Single-phase Systems					
120 or 120/240	120 or 120/240	120 or 120/240	120	115	118 or 120
240 or 120/240	240 or 120/240	240 or 120/240	240	230	236
Three-phase Systems					
120	120	120	120	110	118 or 120
*208Y/120	208Y/120	208Y/120	208 or 120	208 or 110	208 or 118 or 120
240	240	240	240	220	236
*480	480	480	480	440	265
600	600	600	600	550	
*2,400	2,400	2,400	2,400	2,300	
*4,160	4,160	4,160	4,160	4,000	
4,800	4,800	4,800	4,800	4,600	
*6,900	6,900	6,900	6,900	6,600	
11,500	11,500	12,000	12,000	11,000	
12,000	12,500	12,000	12,000	11,000	
13,200	13,800	13,200	13,200	13,200	
*13,800	13,800	13,800	13,800	13,200	
22,900			22,900		
34,400			34,400		
43,800			43,800		
67,000			67,000		
110,000			110,000		

* In new installations, or wherever a selection of voltage can be made, these are the preferred system voltages.

Load Center Substations

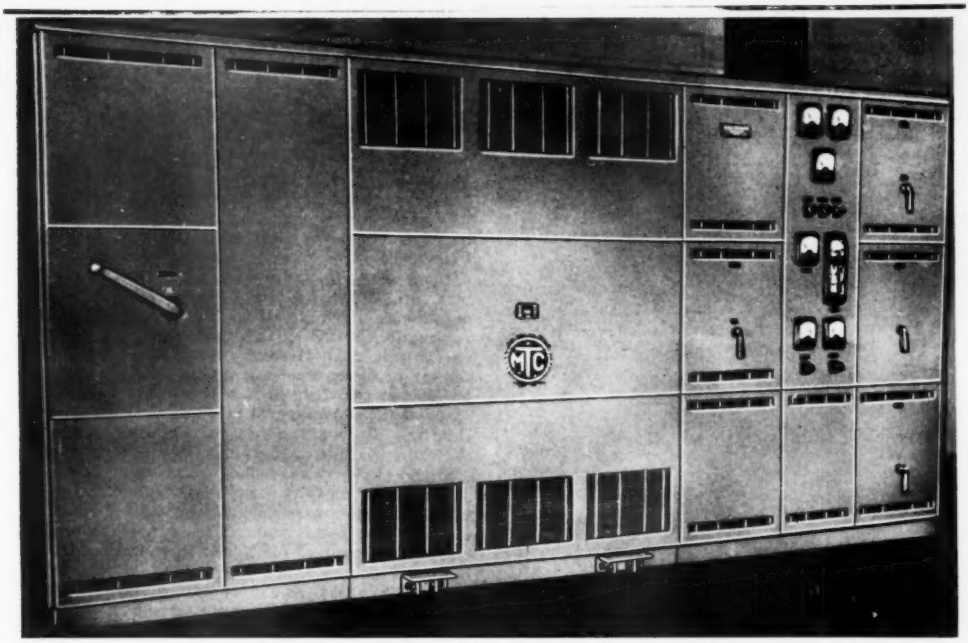
THERE are several ways in which unit substations can be connected into a load center system. Possibly as many as 20, but most designs are of only a few general types. The simple radial system is by far the most popular. Because the service reliability of this system with good equipment properly installed is 99% plus, it has been used successfully in all kinds of industries from garages to those requiring the highest order of service continuity. Such high service reliability is attained because transformer failures are of the order of one failure per 2500 transformer years. Primary cable failures run about one per 100 circuit miles per year. Such a system appeals to plant engineers and maintenance men, because it is safe, flexible, simple, easy to operate, provides good voltage regulation, can be cared for by the average electrician and is lowest in cost of all the systems. It appeals to consulting engineers because it is simple and easy to lay out and adaptable to any plant.

Where slightly greater flexibility and the ability to take a feeder or transformer out of service without dropping load is desired, the simple radial system can be modified with a normally open tie between pairs of substations or double ended substations used to form a secondary selective system. The two substations normally operate as straight radial substations. In case one primary feeder or transformer is purposely or inadvertently taken out of service, the load normally supplied by these substations is supplied from those other feeders by operating breakers. If the load is too great for the remaining transformers, then some nonessential load must be dropped for the duration of the outage or some reserve transformer capacity provided. This system is, in effect, two simple radial systems with a secondary tie between them. Hence this system has all the appealing qualities of a simple radial system, i.e., safety, ease of operation, simplicity, good voltage regulation. It can be cared for by the average electrician and has additional benefits of flexibility for operating purposes, and theoretically somewhat greater service reliability because of the normally open secondary tie between substations. Complication over radial systems is not increased because the transformers are not parallelled. Cost is increased from 5 to 15%, depending largely upon the amount of reserve transformer capacity provided.

In popularity, the secondary selective system ranks second to the simple radial system. It has been used in about every kind of manufacturing plant and has met most exacting requirements of the most critical processes in chemical plants, paper mills, steel mills, petroleum references, drug plants, and other industries.

Secondary network systems have been used to a limited extent. They differ fundamentally from the radial systems in that all transformers are operated in parallel on the secondary. There are probably around 25 or 30 companies using secondary networks, compared with over a thousand companies using the straight radial and secondary selective systems.

The network system with adequate interrupting capacity switchgear on the secondary side has a theoretically slightly greater service reliability than the secondary selective system because a transformer or primary feeder can be relayed off automatically with no loss of service. Under similar circumstances in a



UNIT SUBSTATION with 4160 volts primary, 480 volts secondary at 1000 KVA. Unit consists of primary switchgear, transformers, secondary switchgear, metering equipment.

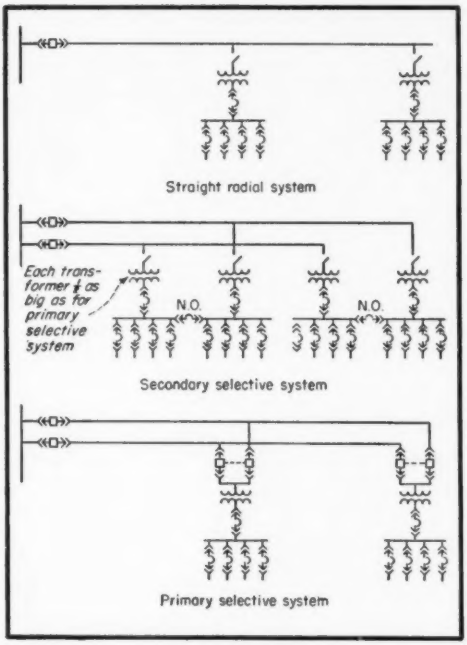
secondary selective system, service would be restored by automatic throw-over in a second or so, or manually as soon as the operator could open one main secondary breaker and close the tie breaker.

Parallel operation of the substation poses certain problems. The short circuit current from each transformer can now contribute to a fault anywhere in the system. Hence, considerably larger interrupting rating secondary switchgear is required. Larger, more expensive cable tie circuits are required to connect all units with at least two tie circuits for selectivity purposes. These two items usually make the secondary network of the order of 50% more expensive than a secondary selective system.

In many instances, there has been a tendency to attempt to lower the cost of network systems at a sacrifice in safety and reliability. One sacrifice is to use primary double throw disconnecting switches; so that, if a primary feeder fails, the transformers connected to that feeder may be transferred to another so as to not lose any transformer capacity. The second is the use of inadequate interrupting rating secondary circuit breakers. This is a hazard and may reduce the service reliability performance of the secondary network system below that of other systems.

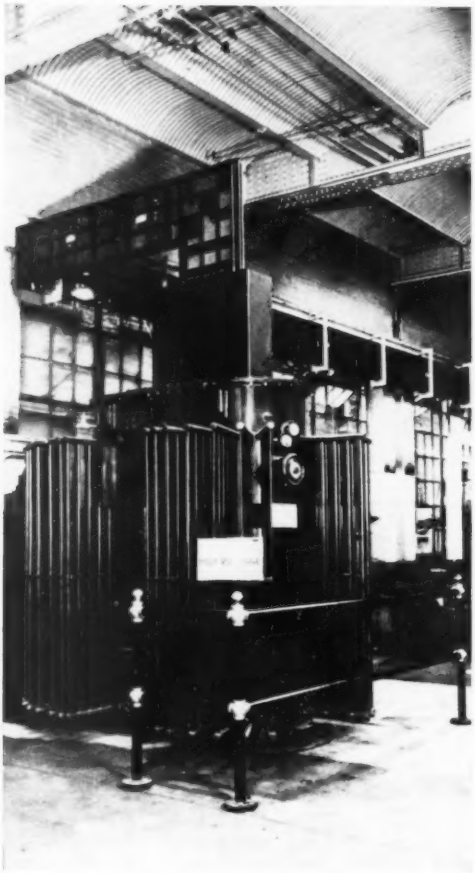
Another form of primary feeder is the looped type in which the feeder starts at a source of power, makes a circuit and ends at a source of power.

The loop primary feeder system, with power circuit breakers for sectionalization, finds application in heavy industrial circuits like those used in steel mills, where the loads occur in large concentrated blocks such as at mill motor rooms.



THREE TYPES of systems using load center substations. Radial system is simplest and has a single feeder and no interconnection between secondaries. Secondary selective system permits disconnecting transformers for maintenance without interrupting service. Primary selective system allows choice of feeders for service reliability. Other combinations or variations are often practical for specific installations.

Busways



LOW IMPEDANCE ventilated bus used as secondary main feeder from a transformer.

DURING the past ten years, busway systems have grown to great importance as a means of delivering electric energy. Basic to industrial work, they have also found application in many other types of buildings.

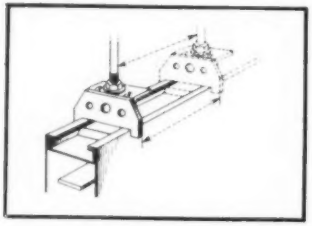
Busways solve the problem of providing a convenient, safe, flexible method of delivering electrical power at utilization voltages. They may be assembled into a power distribution system that can be used to transport power from the low voltage side of the transformer or other secondary source to the distribution switchgear or panelboards, and from the switchgear to other electrical equipment or point of utilization. With this type of distribution, it is not necessary to know the exact location of machines. Bus duct is standardized and highly salvageable.

Essentially, busway consists of a simplified arrangement of copper bars enclosed in a rigid sheet steel housing. The lengths and fittings are factory engineered and standardized. The necessary elements may be easily selected to fit any electrical distribution system. Plug-in devices can be safely and conveniently removed and relocated without even a momentary shutdown of the other equipment energized by the duct. Any plant engaged in the manufacture of products which are subject to model changes annually, or even more frequently, will find busways almost indispensable. Machines may be moved without shutdown of adjoining equipment.

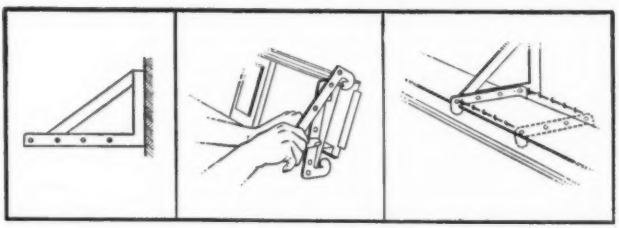
There are four general types of busways: plug-in duct, short run feeder duct, weatherproof duct, and low-impedance duct. Each type has its own features which make it particularly adaptable to specific applications.

Plug-in duct meets most requirements of industry and is the type most generally used. Its most common application is for branch circuit runs, because it is provided with insulated receptacles every foot where power take-offs may be made. It is also frequently used as a feeder duct on short runs. It is required where it is desirable to make several tap-offs from the feeder between switchgear and other points of distribution. Standard length is a ten foot section. Special lengths are also available to meet special requirements.

Plug-in duct is normally available in ratings from 225 amperes to 1500 amperes for single phase, three phase, 3 phase 4 wire ac systems and 2 and 3 wire dc



MOST COMMON method of installing duct is with drop type hangers. The hangers shown are of the sliding type. Hanging rods may be located wherever convenient, and slide hangers moved to the proper position for exact alignment of the distribution system.



TYPE OF HANGER available for those installations in which it is desirable to mount the duct close to the wall, ceiling, or cross member. Known as the "C" hanger, it consists of a 2-piece mounting bracket which clamps over the side of the duct. Supports are normally required for every five feet of the run.

Eleven Basic Fittings

ELBOWS are used to make right angle turns. There are four types: forward, rearward, upward and downward.

TEES are used where a tap-off is required to obtain an additional run of duct in another direction. Four tees are available: forward, rearward, up and down.

CROSSES are used where more than one tap-off is required at the same location in the main duct run. Since the duct can be installed in only two positions, there are only two crosses.

OFFSET is used to avoid interference with pipes or structural members. There are four types: right rearward or left forward, right downward or left upward, right forward or left rearward, right upward or left downward.

UNFUSED REDUCER ADAPTER is used wherever it is desirable to reduce the capacity of the duct without using an overcurrent protective device.

EXPANSION JOINT is used to compensate for the difference between the coefficient of expansion for steel (.0000064 per degree F) and copper (.0000091 per degree F). It is good practice to install an expansion joint in the middle of any run of 100 feet or more.

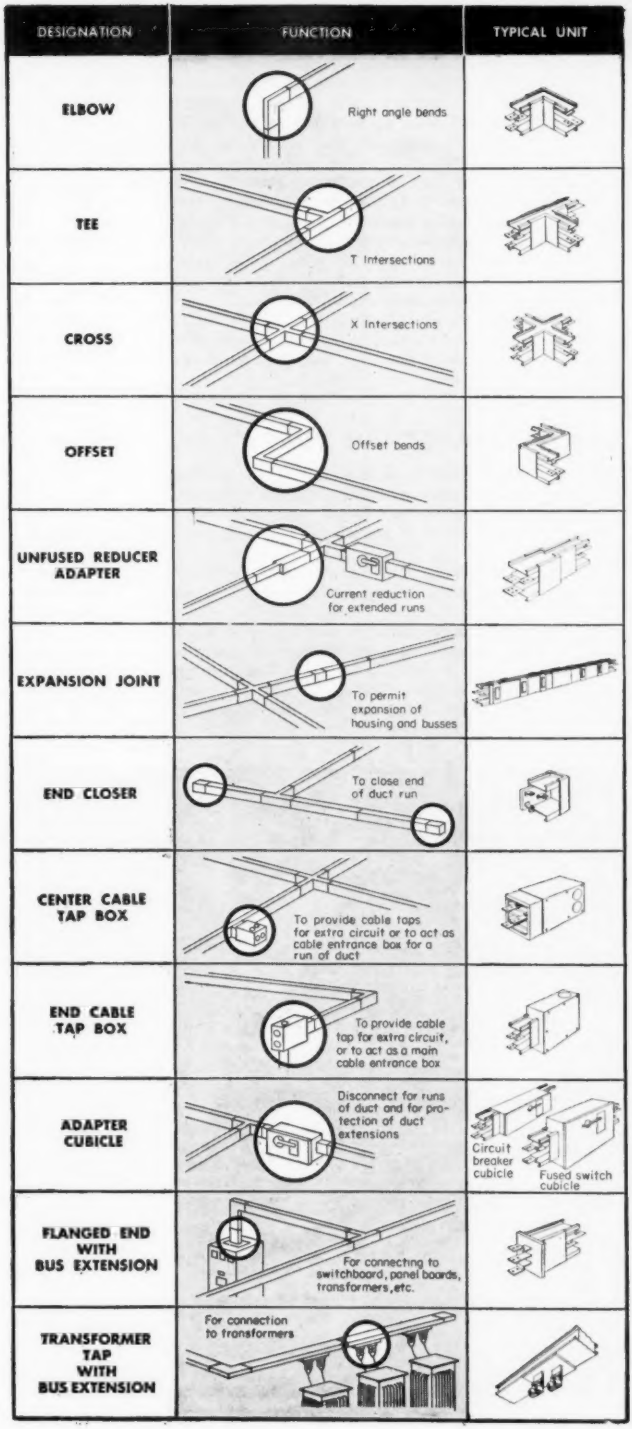
END CLOSER is used to close the end of the duct run. It is a simple device which closes the end of the duct and provides a place to secure the bus bars. There are two types: right and left.

CABLE TAP BOXES are used where the duct is fed by cable, or where equipment fed by the bus is fed by cable of a size that does not require overcurrent protection. The cable tap boxes may be mounted at the ends or at any intermediate joint. They are divided into two general classifications which indicate this alternate: "End" cable tap box, or "center" cable tap box. The end cable tap boxes are available for either right or left end. The center cable tap boxes are available for either front or rear.

ADAPTER CUBICLES are required when a reduction in bus capacity is made where the smaller bus has a capacity of less than one third of the rating of the overcurrent protective device next back on the line, or where the reduced run is more than 50 feet. Each cubicle contains either a circuit breaker or fused type of overcurrent and disconnect device. The line side of the cubicle is connected to the large section of duct, and the load side to the reduced section. In addition to supplying overcurrent protection to the smaller duct, it offers a convenient method of disconnecting or isolating that section of the duct run.

FLANGED END is used to connect the duct to the switchboard, panelboard, current transformer cabinet, or pull-box. There are two types for right or left end.

TRANSFORMER TAP shown is, as the name implies, used for connecting the bus to the transformer bank.


DESIGNATION
FUNCTION
TYPICAL UNIT
ELBOW
Right angle bends
TEE
T Intersections
CROSS
X Intersections
OFFSET
Offset bends
UNFUSED REDUCER ADAPTER
Current reduction for extended runs
EXPANSION JOINT
To permit expansion of housing and busses
END CLOSER
To close end of duct run
CENTER CABLE TAP BOX
To provide cable taps for extra circuit or to act as cable entrance box for a run of duct
END CABLE TAP BOX
To provide cable tap for extra circuit, or to act as a main cable entrance box
ADAPTER CUBICLE
Disconnect for runs of duct and for protection of duct extensions
Circuit breaker cubicle
Fused switch cubicle
FLANGED END WITH BUS EXTENSION
For connecting to switchboard, panel boards, transformers, etc.
TRANSFORMER TAP WITH BUS EXTENSION
For connection to transformers

systems operating at 600 volts or less. Normally, a half size neutral is supplied for 3 phase 4 wire systems. Since the neutral carries only the unbalanced current, the half neutral is satisfactory in most applications. However, when the duct is used to serve a lighting load or the lighting load is an appreciable part of the total power load, it is recommended that a full size neutral be used.

Short run feeder duct is normally available in sizes up to 4000 amperes. It is used in applications where the voltage drop is not excessive, or where it is desirable to introduce some reactive element in order to limit the amount of energy that may be delivered in the event of a fault. As the name implies, these runs are usually short and rarely exceed 200 feet.

The construction of this duct in sizes up to 1500 amperes is identical with plug-in duct, except that it has no openings along the duct in which plug-in devices may be inserted.

LOW IMPEDANCE BUS DUCT

Low impedance bus duct is used to transport large amounts of energy over relatively long distances where voltage drop is an important factor, and where it is impossible or impractical to install capacitive corrective devices.

The reactive impedance of the duct is reduced by close spacing of the bus bars and "pairing" opposite phases.

The use of low impedance bus duct makes it possible to effect a considerable economy in the amount of copper necessary in a distribution system. The insulation of any conventional type of conductor will deterioriate rapidly if it is operated for any considerable length of time above its maximum operating temperature. As conductors increase in size, it becomes more difficult to dissipate the heat losses. This fact is recognized by the National Electrical Code. For example: if 1,000,000 cir. mil Type RH conductor is increased 50% in size to 1,500,000 cir. mil, the current carrying capacity of the conductor is only increased 80 amperes, a little less than 15%. In the plug-in and short run feeder types of bus duct no insulation is used on the bars and consequently the temperature limitation problems of conductors do not exist. In low impedance bus duct, the bars are wrapped with a very high grade insulation tape which is capable of withstanding high temperatures; the duct is ventilated and the bars arranged so that the heat losses may be quickly dissipated.

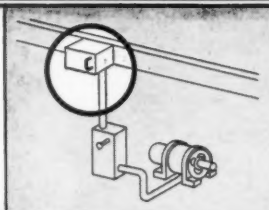
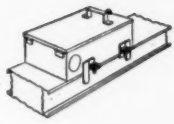
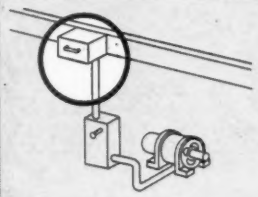
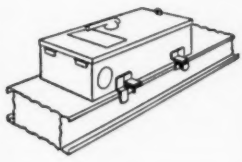
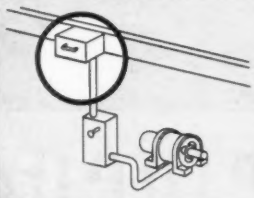
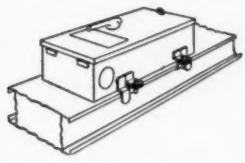
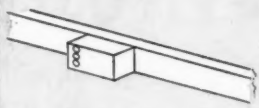
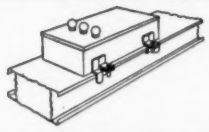
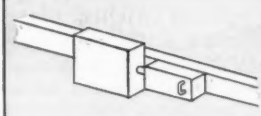
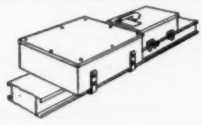
A special type of bus system with ever widening areas of application is the trolley busway, also known by manufacturers trade names such as Trol-E-Duct, Flex-A-Power, Feedrail and Trac-Troly.

Enclosed buses are contacted by rolling or sliding connectors. The traveling collector can be readily moved along the duct, providing a mobile supply of energy for portable tools, products requiring testing on a moving assembly line and like applications.

Such systems are also finding a place in commercial and industrial lighting, permitting concentration or dispersal of lighting fixtures to the requirements of an area at will.

Prospective development in the immediate future will probably be in the direction of new adaptations of present bus systems to distribution problems. The method is still relatively new, however, and further developments in design, variety of units and parts, ratings, and special features to provide for installation under different surroundings and use requirements will be forthcoming.

MAIN LOW IMPEDANCE feeder serves distribution runs of plug-in bus in an industrial installation.

DESIGNATION	FUNCTION	TYPICAL UNIT
COVER OPERATED FUSIBLE PLUG-IN DEVICE	 Cover operated fusible take-off	
TYPE A SAFETY SWITCH PLUG-IN DEVICE	 Type "A" safety switch for use on motor and heavy duty industrial circuits	
CIRCUIT BREAKER PLUG-IN DEVICE	 Circuit breaker of approved type	
NEUTRALIZER AND GROUND DETECTOR PLUG-IN DEVICE	 For quickly indicating grounds on a system, and to dissipate static electricity	
CAPACITOR PLUG-IN DEVICE	 For improving power factor or voltage conditions	

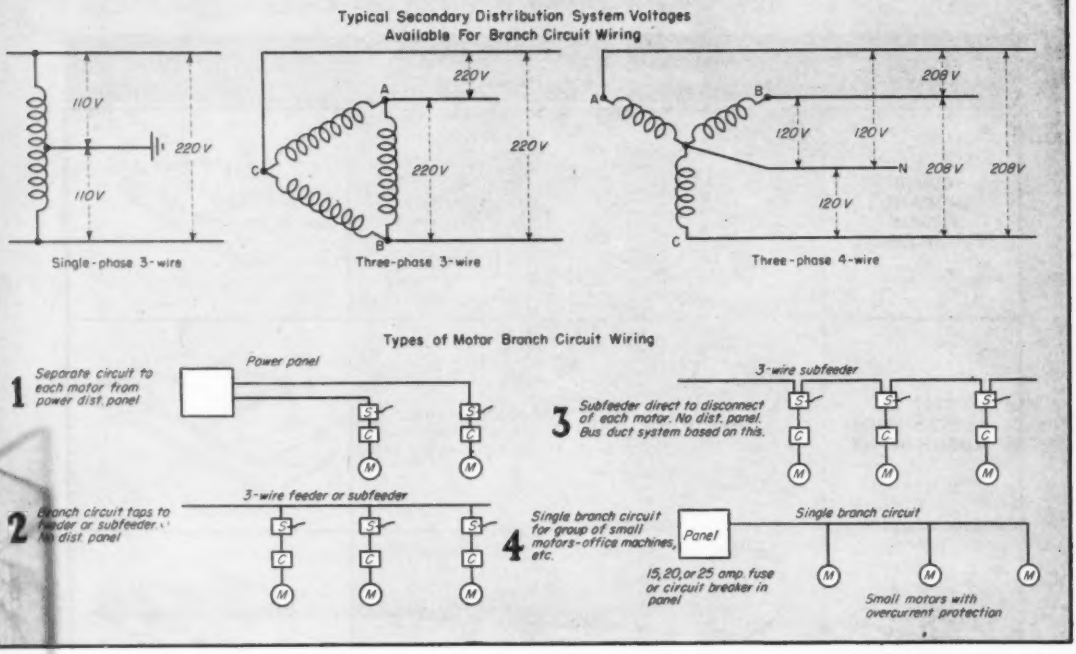
CIRCUIT BREAKER TYPE PLUG-IN DEVICES are available in ratings from 15 to 600 amperes. The tripping element of the breaker functions to trip when either a prolonged overload becomes dangerous, or when a dangerous heavy overload develops. All poles are simultaneously tripped, eliminating the possibility of "single-phasing." The circuit is restored after the fault is cleared simply by moving the handle. There are no fuses or parts to replace or repair.

TYPE A FUSIBLE SWITCH is designed for use on motor or heavy-duty industrial circuits. It is horse-power rated, cover-interlocked and has quick-make and quick-break action. No unauthorized person can open the switch when it is in the "on" position.

COVER-OPERATED FUSIBLE SWITCH PLUG-IN is horsepower rated up to and including 100 amperes. The switch blades are fastened to the cover so that when the cover is opened the switch is in the "off" position. It is impossible to gain access to the fuses when the switch is in the "on" position.

GROUND DETECTOR AND NEUTRALIZER PLUG-IN is used to discharge any static electricity that the bus system may accumulate, and it also serves as a ground detector. The unit consists of high resistances in series with neon lamps connected between the bus bars and ground. Normally the neon lamps will burn continuously. If there is a ground any place on the system, it will be of lower resistance than the corresponding resistor in series with the lamp. This will cause the lamp to go out, indicating a ground on the phase to which that lamp was connected.

CAPACITOR PLUG-IN UNITS are available to make power factor corrections and improve voltage conditions where needed. They have the advantage of confining the magnetizing current requirements to the circuit between the inductive apparatus and the capacitor. Capacitor plug-in units will decrease the losses in the duct, increase the effective voltage, improve the voltage regulation, and decrease the losses in any transformers in the distribution system. Most power companies make an extra charge for any system power factor of less than 0.8. Investigation may prove that the savings in power rates alone may more than pay for the purchase of capacitor plug-in units. It is a convenient method of solving most power factor problems.



BRANCH CIRCUITS

New materials, new methods of installation and new theories concerning current characteristics are being applied in power, lighting, hazardous-location, and special wiring plans.

THE basic requirements of any electrical system design and layout are flexibility, adequacy and operating economy. This is just as true of branch circuits as of any other part of the system. These circuits must carry electrical energy at full utilization voltage from the last distribution center in the area to the individual power or lighting outlet. They should be accorded the same engineering consideration as is given the rest of the system design.

Flexibility of branch circuit layout is a prime factor, particularly in large industrial and commercial buildings. This is the one part of the entire electrical system which is subject to periodic or frequent change due to relocation of production lines, changes in production schedules or a general reshuffling of plant or office layout.

Adequacy and spare capacity for future expansion are normally designed in the service and distribution feeders. They should also be considered in branch circuit design and provisions made to permit addition of future circuits and loads at minimum cost.

The present trend is to keep branch circuits to the shortest practicable length, with adequate capacity to keep voltage drop to a minimum at full load conditions. This is accomplished by using higher voltages for system distribution to numerous highly concentrated load centers and stepping down to utilization voltages through transformer banks or unit substations. At first glance, this may appear more costly than the old method of a single transformer bank and long secondary circuits. Actual cost comparisons have proved that the short branch circuit and high voltage distribution system is more economical—principally through savings in copper and lower operating costs.

Basically, there are three types of branch circuit systems to carry standard utilization voltages to power and lighting outlets. They are:

1. *Single-Phase, Three-Wire System*—commonly used for lighting and small motor loads (not exceeding five hp) at 115/230 volts. Branch circuits may be 115/230 volt, 3-wire for combination lighting and power; 115-volt, 2-wire for lighting alone; or 230-volt, 2-wire for power.
2. *Three-Phase, Three-Wire System*—used at 230 or 460 volts primarily where motors constitute the predominant load. The higher voltage is used for large connected loads where economies in wiring can be effected. At both voltages lighting circuits can be taken off this system

BRANCH CIRCUIT CONDUITS are carefully racked in tiers and terminated in templates at panel locations before concrete floor is poured.

through individual insulating step-down transformers. Or, lighting can be supplied through a separate service and distribution system.

3. *Three-Phase, Four-Wire System*—a combination system providing both power and lighting branch circuits at 120/208 volts. Among the various circuits obtained from this system are: 4-wire, 120/208-volt; 3-wire 120/208-volt; 3-wire, 208-volt; 2-wire, 208-volt; and 2-wire 120-volt.

For most commercial buildings and smaller industrial plants, the three-phase, four-wire combination system provides considerable copper economy and is the most commonly used. Larger industrial plants use the three-phase, three-wire system at higher voltage and take off lighting service through step-down transformers.

Regardless of the branch circuit system or voltages used, design consideration must be given to voltage drop. Accepted over-all *maximum* voltage drop permissible, at full load conditions, from service switch to center of load of the most remote branch circuit is as follows:

For Lighting Circuits..... 3%
For Power Circuits..... 5%

Normally, proper feeder design will limit voltage drop for lighting distribution to a maximum of 1%; for power, 3%. Thus the permissible maximum drop in branch circuits for any wiring system is limited to 2%.

Available to the engineer and contractor are various types of materials for branch circuit layout and installation. Choice of a specific material or wiring sys-

COPPER REQUIREMENTS OF BRANCH CIRCUIT SYSTEMS*

TYPE OF SYSTEM	AMOUNT OF COPPER IN PERCENT
Single-Phase, 2-wire, 115-volt	100
Single-Phase, 3-wire, 115/230-volt	53
Three-Phase, 3-wire, 230-volt	20.9
Three-Phase, 4-wire, 120/208-volt	26.4

*Assuming the weight of copper for a single-phase, 2-wire, 115-volt system is 100 percent. Then to transmit 50 kw. of unity power factor load a distance of 100 feet, with a maximum of 2 percent voltage drop, using Type RH conductors, the common systems listed above will require the amounts of copper indicated.

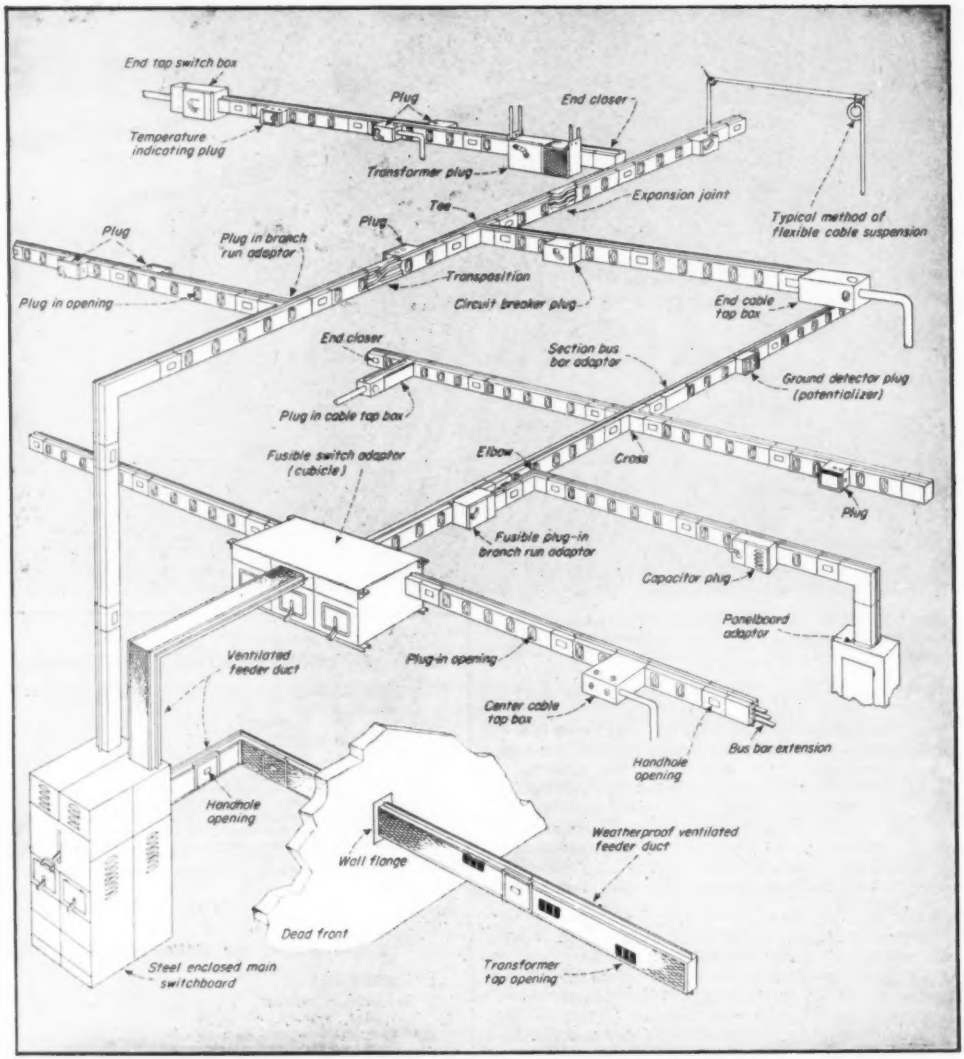
Data from Standard Handbook for Electrical Engineers, McGraw-Hill Book Company

WIRING SYSTEMS FOR BRANCH CIRCUITS

CABLE ASSEMBLIES
- Open wiring on insulators
- Non-metallic sheathed cable
- Flexible metallic armored cable
- Armored cable for special purposes

RACEWAYS FOR STANDARD CABLES
- Rigid conduit — steel and aluminum
- Thin-wall electric metallic tubing
- Flexible metallic conduit
- Non-metallic ducts
- Surface metal raceways
- Under plaster raceways
- Metallic wireways
- Underfloor duct — metallic and non-metallic
- Cellular steel flooring

BUSWAYS
- Plug-in bus duct — 50 (midget duct) to 1,000-ampere capacity at 600 volts, three-phase, three-wire and four-wire. Feeder duct capacities range from 600 to 4,000 amperes in general.
- Trolley duct — 50 ampere, 2, 3, or 4-pole type at 225 volts for lighting; 100, 200 and 400-ampere, heavy duty type, 2 and 3 pole type for power.



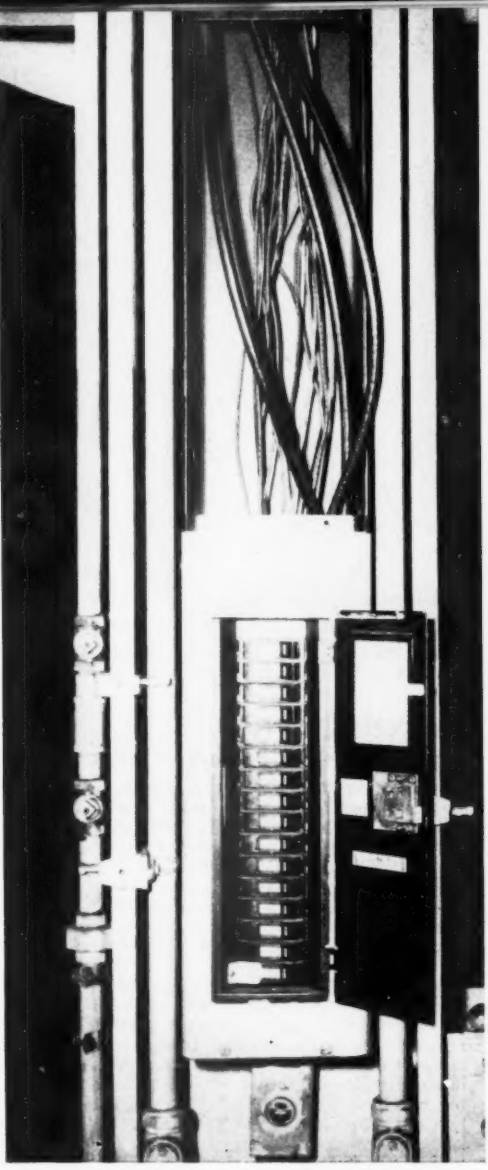
POWER BRANCH CIRCUIT flexibility is provided by a bus duct system. Note number of different accessory plug-in units available for motors, power factor correction, temperature indication, ground detection and voltage transformation. Entire system can be quickly relocated and reused if production equipment is shifted or moved to different quarters.

tem is based upon a number of considerations. Among these are: first cost; type and total power and lighting load; degree of flexibility desired; type of building construction; type of operation to be carried on in the structure; physical size and shape of the building; installation and operating economy.

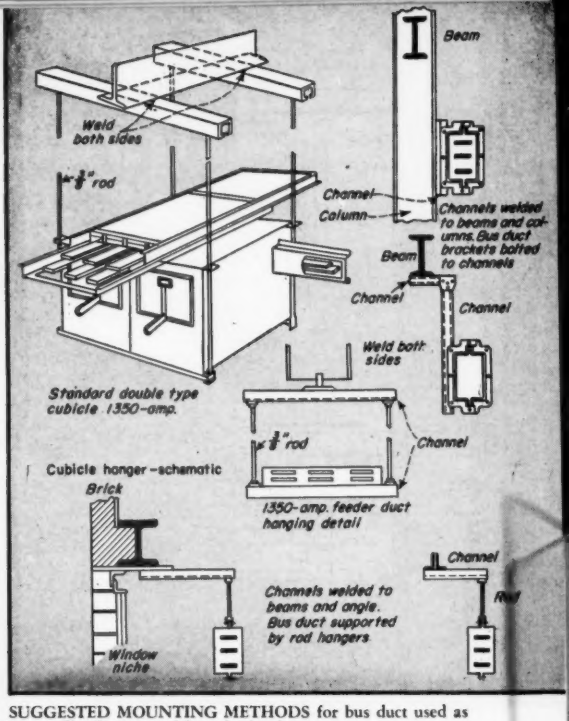
POWER CIRCUITS

The need for branch circuit flexibility in the electric power distribution system of a modern industrial plant is being met by the choice of plug-in type bus duct and heavy duty trolley duct as the wiring method. The ease with which this equipment can be installed, its salvability when relocated and the ease with which machine connections can be made and removed are features which permit equipment relocation and department reorganization with minimum shutdown time and electrical rehabilitation cost.

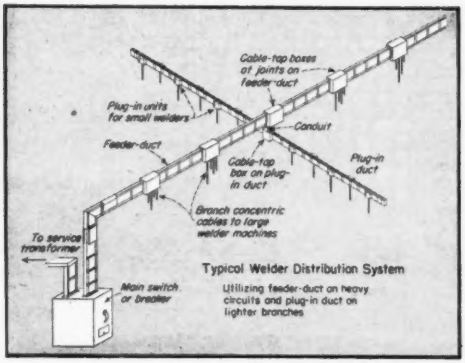
Plug-in duct is used primarily to serve machine tools and other stationary equipment. Heavy duty trolley duct is finding increased application where a mobile source of power is required for portable tools along a production line, and light weight electric crane and monorail installations. Overcurrent protection for motors is contained in the plug-in disconnect attached to the duct. Trolleys and take-off devices for trolley



ACCESSIBLE WIREWAYS to column-type lighting panels house both panel feeder and branch circuit conductors. Panel and wireway are set in web of column.



SUGGESTED MOUNTING METHODS for bus duct used as power distribution and branch circuit system.


Cable-tap boxes at joints on feeder duct
Plug-in units for small welders
Conduit
Feeder duct
Cable-tap box on plug-in duct
Plug-in duct
Branch concentric cables to large welder machines
To service transformer
Typical Welder Distribution System
Utilizing feeder-duct on heavy circuits and plug-in duct on lighter branches
Main switch or breaker

ELECTRIC WELDER distribution and branch circuit system using bus duct method. Note use of concentric cables.

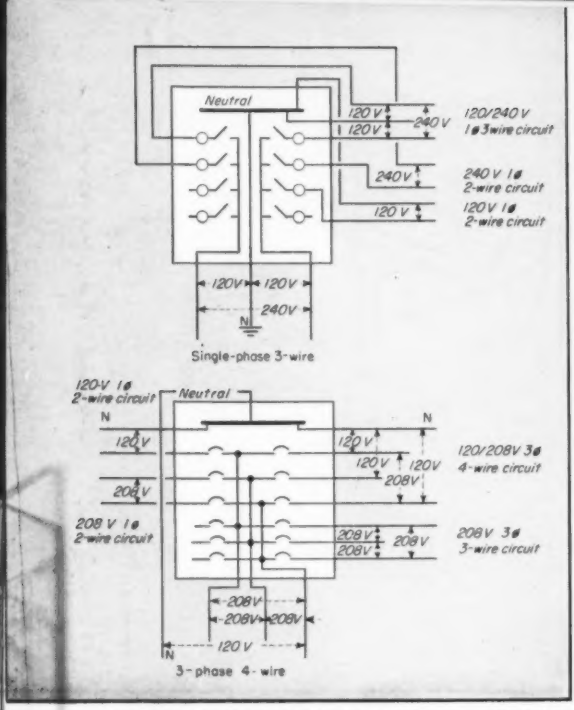
duct can be inserted or removed with a twist of the wrist or pressure on a lever.

These enclosed busways are supplied in standard 10-foot sections with a variety of offsets, elbows, tees, expansion joints and tap boxes designed to solve most installation problems. Ground detector plugs and capacitor plugs are also available for use on the duct. It is difficult and costly to cut duct sections to fit on the job. Hence the contractor must take accurate measurements and make a dimensional layout before ordering the material. The necessary special sections required to complete the layout are then fabricated at the factory.

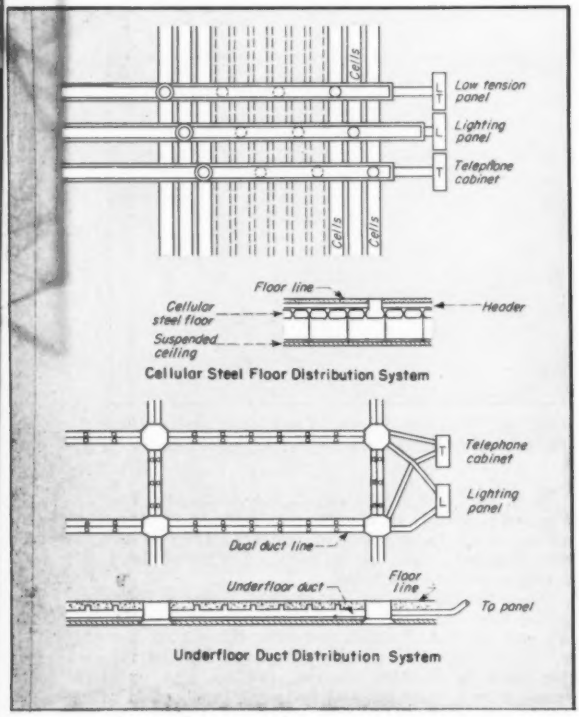
When used as a branch circuit, the length of a busway run is limited, in general, to a distance (in feet) not to exceed three times the ampere rating of the branch circuit (NEC, section 3652). And power distribution panels are eliminated.

Where flexibility is not the dominant factor in power branch circuits, any of the other standard wiring methods may be used. Conduit and cable circuits are normally run overhead or in the floor from the distribution panel to machine location. Surface type metal raceways and wireways also find ready application to enclose power branch circuit conductors.

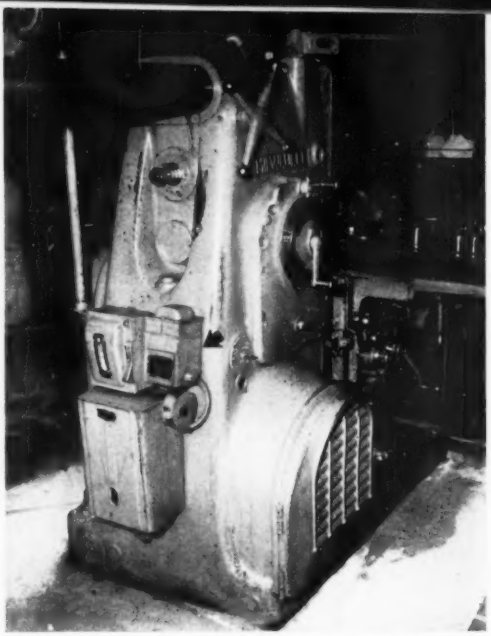
One of the newest wiring systems recently placed



TYPICAL BRANCH CIRCUITS available at standard lighting distribution panels.



UNDERFLOOR DUCTS provide multiple-outlet branch circuits in commercial building and office installations.



SMALL TRANSFORMER connected to motor branch circuit provides 110-volt convenience outlet on this machine.

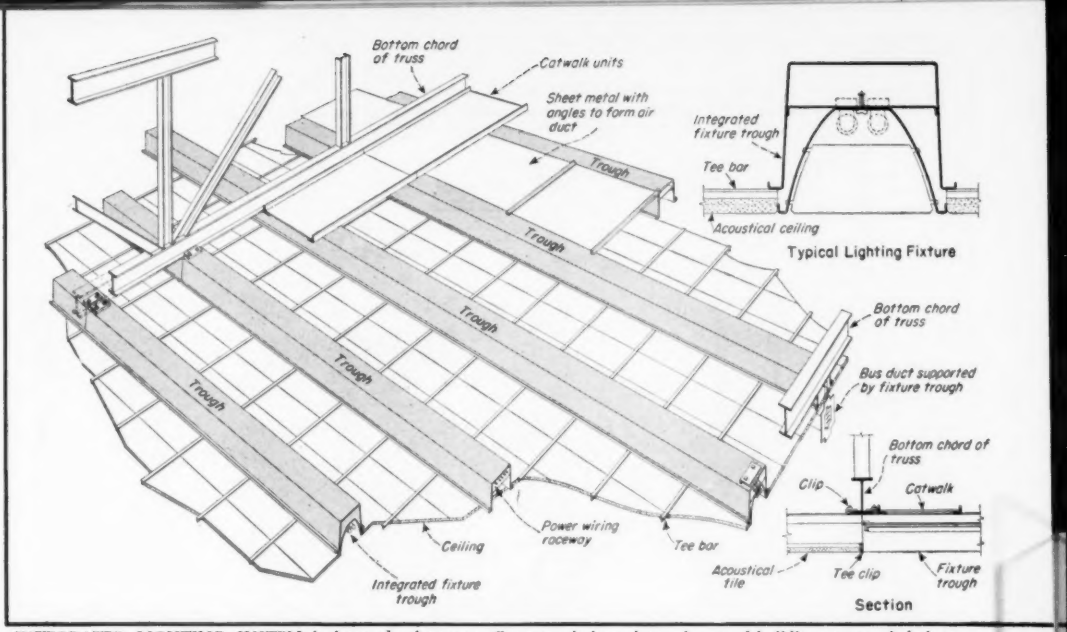
LOOKING AHEAD IN WIRING DESIGN (continued)

on the market for branch power circuits is an over-size underfloor duct for use in single-story industrial plants with thick concrete floor slabs. Patterned after the conventional type of underfloor duct, this equipment consists of standard lengths of 4-in. square metal wireway with 2¼-inch high inserts on 20-inch centers. Each insert is threaded for a 2-inch conduit nipple. Installation techniques are similar to those used for the commercial type of underfloor raceway having smaller cross sectional areas.

Regardless of the type of wiring system chosen for installation, original design calculations should take into consideration the power factor of the load connected to the branch circuits. Low power factor loads cause additional voltage drop and heating in the branch circuits and feeders. Power factor of induction motors can vary from 60% to 90% depending on type, size, speed and load. And, for some types of welding loads, the power factor may be as low as 40%.

Low power factor can be corrected by installing capacitors in the circuits. These may be added in large banks at the unit substation, in smaller groups at distribution centers or as individual units at the load point. When located near the load, the resultant efficiencies will then be carried from the capacitor back to power source effecting utility rate economies. A condition of leading power factor under normal conditions is rarely encountered, however, can be corrected by adding reactance if necessary.

Every alternating current circuit has a reactance drop which depends upon the conductor size, spacing between conductors, their arrangement, frequency of the supply and presence or absence of magnetic materials. Reactance drop can be reduced by using nonmetallic conduits. For small size conductors, such as used in lighting circuits, this reactance drop can usually be neglected. However, for heavier circuits and



INTEGRATED LIGHTING SYSTEM is latest development in lighting installation technique. Patented by the Austin Company, it is an integral part of building structural design. Troffer-beams house lighting fixtures and wiring.

cases where power factor is considerably lower than unity, reactance should be considered in determining voltage drop.

LIGHTING CIRCUITS

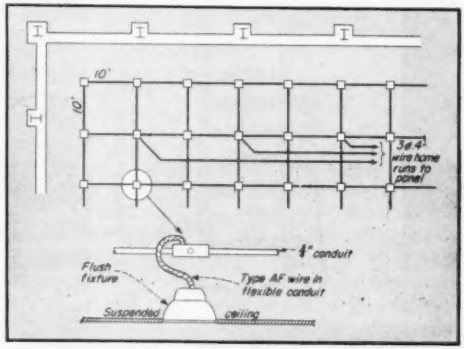
Lighting branch circuits originate at a distribution center of the conventional fuse-switch or circuit breaker panel type. While home-run circuits are normally run in conduit, the growing acceptance of the narrow column-type lighting panel has led to the continued use of a vertical wireway to enclose these cables. Usually, such a wireway extends to a pull-box at the ceiling or roof-truss level where conduits extend the circuits to the rows of lighting fixtures.

In many large industrial plant applications, lighting fixtures are mounted to a channel for rigid support and to reduce the number of suspension rods necessary to hold the line of units. Branch circuit conduits are normally mounted to this channel. Or the channel itself, if it is enclosed and permission of local inspection authorities can be obtained, can be used to enclose the circuit conductors.

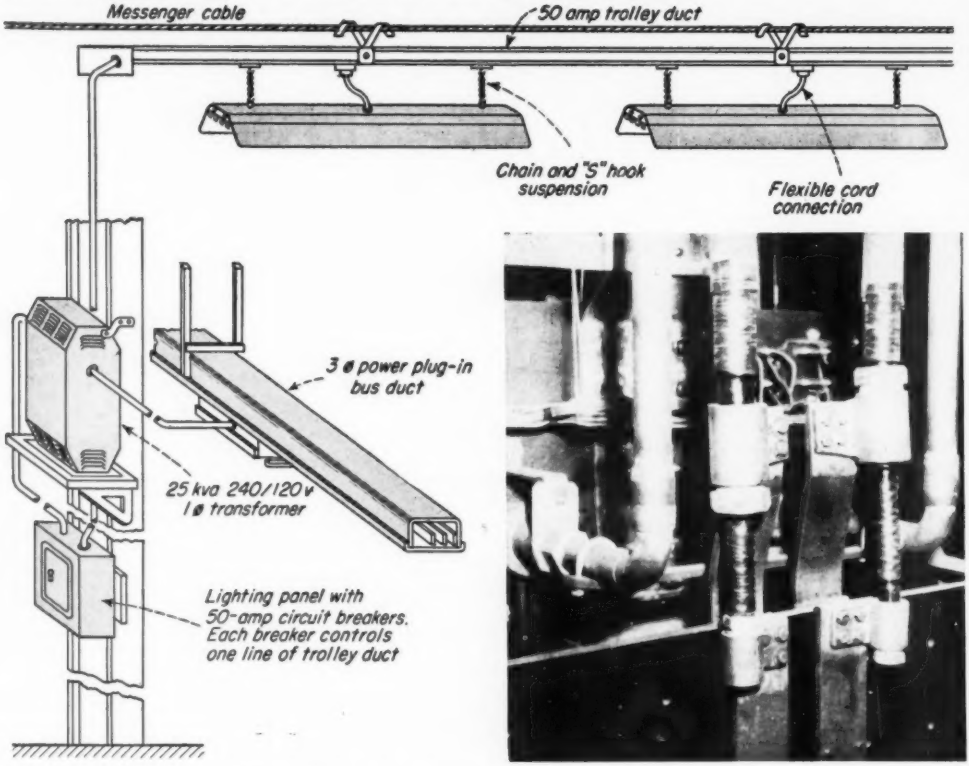
General acceptance of continuous row fluorescent lighting for both industrial and commercial applications has greatly simplified branch circuit wiring. With fixtures mounted in troffers, or installed end to end, the wiring channel on the fixture unit is generally used to house the circuit wires feeding a group of fixtures. The number of outlet boxes required is thus reduced to a minimum for home runs.

The grid system of branch circuit wiring is being used for a number of large commercial building lighting installations where fixtures are mounted in a suspended ceiling, and a high degree of flexibility is desired for possible changes in office layout. This method consists of suspending outlet boxes on 10-foot centers, 12 inches above the suspended ceiling throughout the entire area. All outlet boxes are tied together with ¾-inch conduit to form a grid. The three phases of a 120/208-volt four-wire circuit are made available at each outlet. Connections to individual fixtures are made from the outlet box with flexible metallic conduit and asbestos insulated conductors. Regardless of where a fixture may be reinstalled, an outlet is always within easy access.

Where spacing of fixtures may be changed frequently to secure higher concentrations of light or to conform to new production set-ups in industrial plants, trolley duct offers an exceptionally flexible type of branch circuit distribution. Available in 50-ampere capacity, it can be installed in continuous rows of any length, with home-run feeds at any point, either on messenger cable or channel suspension or direct to ceiling structures. The fixture with its trolley connection can be moved to any desired location. Stationary twist-type connections are also available. Both types can be quickly removed from the duct for repair or replacement of fixture.

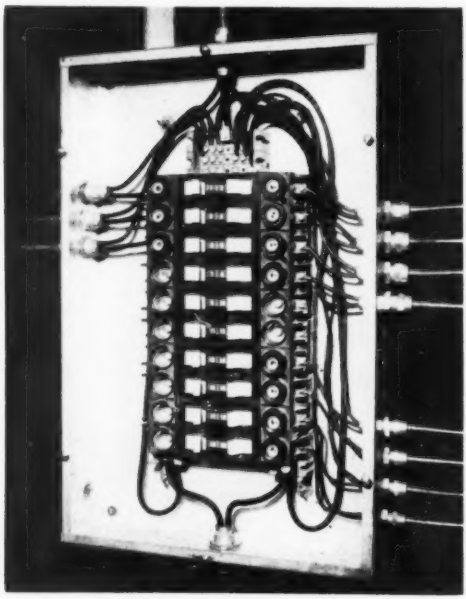


GRID SYSTEM CONDUIT installation for lighting branch circuits in suspended ceiling provides outlet every ten feet.


Messenger cable
50 amp trolley duct
Chain and "S" hook suspension
Flexible cord connection
3 ø power plug-in bus duct
25 kva 240/120 v 1 ø transformer
Lighting panel with 50-amp circuit breakers. Each breaker controls one line of trolley duct

TROLLEY DUCT fed through a transformer from power bus duct provides flexible branch circuit arrangement.

CO-AXIAL CABLE connections made to rear of an induction heating unit in an industrial plant.

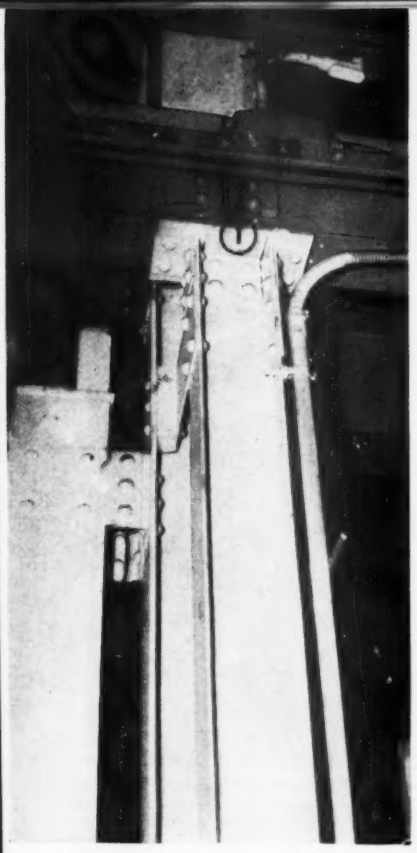


MINERAL-INSULATED wiring branch circuits leave lighting panel in an industrial area where circuits must be protected against heat and moisture conditions.

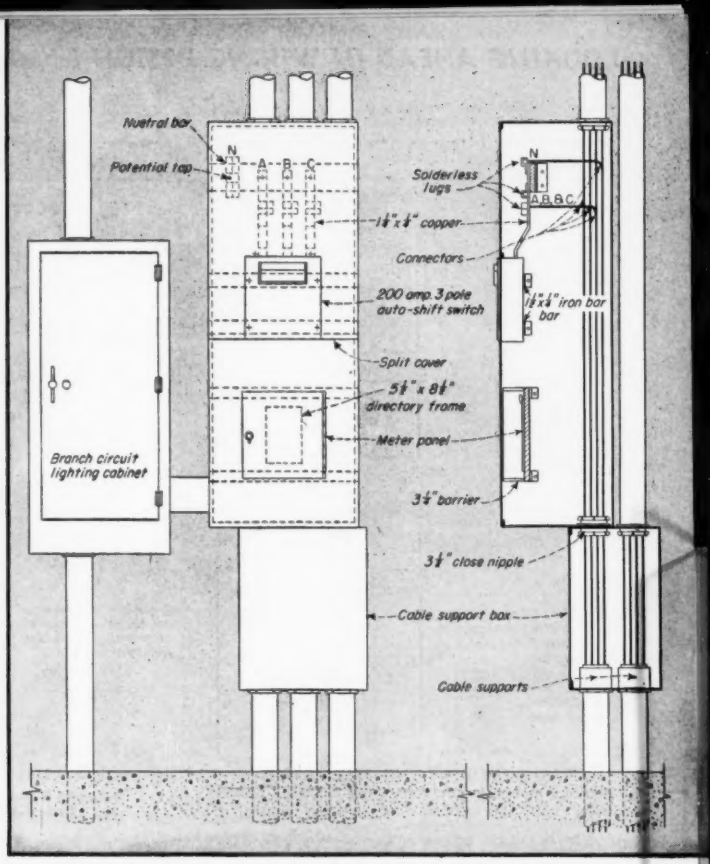
A recent development which has a decided effect on methods of installing lighting fixtures and associated circuit wiring is the Integrated Ceiling Lighting System. This type of ceiling provides a simple means of installing fluorescent lighting systems in industrial plants, commercial buildings, institutions and other structures. The system employs a specially designed trough-shaped structure called a "trofferbeam" since it supports the ceiling installation as well as forming a raceway for fixtures and their associated circuits. The troughs are normally mounted to roof truss structures, with toe clips, on 3, 4 or 5 foot centers. Troughs not used for fixtures at present can be covered over with ceiling tile and used at a later date when lighting intensities might be increased. Power bus duct runs can also be suspended from troughs not used for lighting.

Underfloor duct systems are the accepted method of providing multiple outlets for local lighting and small business machine motor loads, and telephone circuits in commercial buildings. In the case of existing structures, surface type raceways with multiple outlet assemblies can be used to advantage.

For localized lighting where required at machine locations in industrial plants the 110-volt circuit is



INDUSTRIAL TROLLEY DUCT serves as feeder to small bridge crane.



EQUALIZER PANELS installed ahead of lighting branch circuit panel equalizes load fluctuation between floors fed by same riser.

taken directly from the power drop to the motor through a small 75 or 100-watt single-phase transformer mounted to the machine. Normally, such a unit also includes a convenience outlet for use of extension lamps or portable electric tools.

Another recent innovation, while normally installed ahead of the lighting distribution cabinet, has a definite effect on overall lighting system operation and efficiency. This is the so-called "equalizer panel". The device connects the lighting system serving an area to two sets of parallel feeder conductors through an automatic switch. Its purpose is to equalize the load on the two feeders and utilize the diversity of the feeders. It is normally installed in multiple story commercial and office buildings.

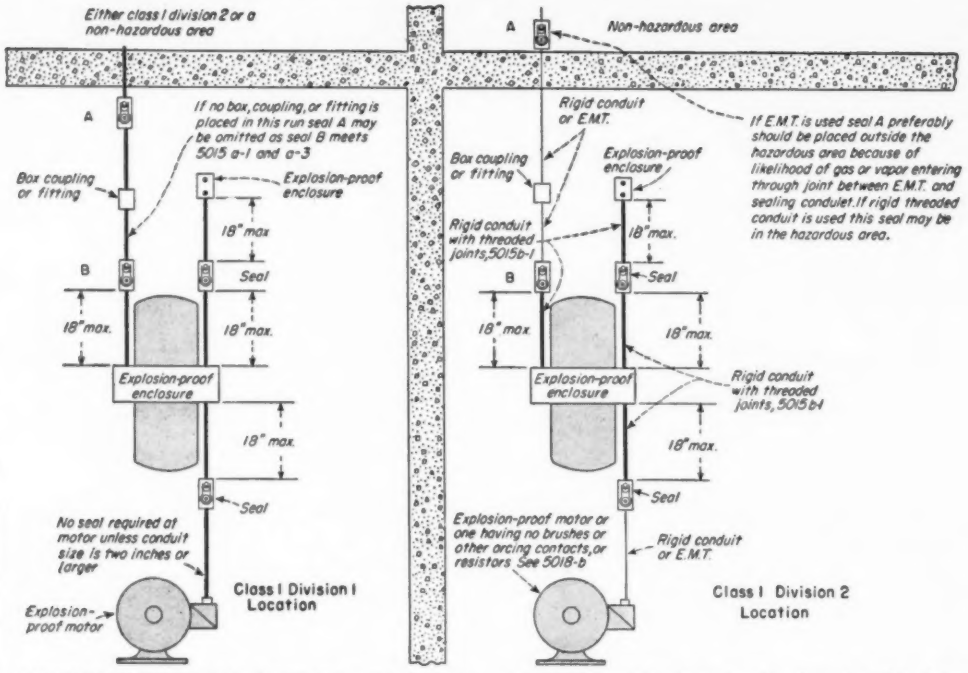
Substantial lighting branch circuit copper savings can be effected by placing lighting distribution cabinets close to source feeders in accessible roof-truss locations. Lighting control is then accomplished by magnetic contactors and remote control stations on an area-wide basis. This method was used extensively during World War II plant construction. Under the present emergency, it may again appear frequently in lighting system design.

Historically, lighting systems have been operated at 115 to 120 volts, either on the single-phase, 2-wire; single-phase, 3-wire; or three-phase, 4-wire circuits previously outlined. At times, in the past, there have been technical papers delivered with subsequent discussions on the feasibility of using higher lighting voltages—particularly on fluorescent lighting installations. While several large industrial plant fluorescent lighting systems have been installed to operate on 277-volt circuits, little has been done to influence and promote general acceptance of higher voltage lighting. In fact, recent reports indicate that high voltage ballasts have been taken off the market. The ballast question seems to be the stumbling block.

It appears contrary to good engineering practice and electrical system economics to connect a fluorescent lamp, which is essentially a 200-volt device, to a circuit voltage of 115 then step this up to 200 or 210 volts through an autotransformer in the ballast at each individual fixture. Furthermore, each ballast contains a carefully matched series capacitor to split the phase to reduce stroboscopic effect.

Most commercial buildings and small plants have 3-phase, 208-volt power available on their 3-phase, 4-wire system. Others have 230 or 240-volts available on their single-phase, 3-wire systems. Why not utilize these higher voltages to operate the fluorescent lighting system and take advantage of the saving in copper? On the 4-wire system, the three phases are available for proper balancing and elimination of stroboscopic effect.

One suggestion has been to take the material in the present ballast autotransformer and make a choke out of it, connect the ballast to a 3-phase system and make


Either class I division 2 or a non-hazardous area
A
If no box, coupling, or fitting is placed in this run seal A may be omitted as seal B meets 501.5 a-1 and a-3
Box coupling or fitting
Explosion-proof enclosure
18" max
B
Seal
18" max.
18" max.
Explosion-proof enclosure
18" max.
Seal
No seal required at motor unless conduit size is two inches or larger
Explosion-proof motor
Class I Division I Location
A
Non-hazardous area
Rigid conduit or E.M.T.
If E.M.T. is used seal A preferably should be placed outside the hazardous area because of likelihood of gas or vapor entering through joint between E.M.T. and sealing conduiet. If rigid threaded conduit is used this seal may be in the hazardous area.
Box coupling or fitting
Explosion-proof enclosure
Rigid conduit with threaded joints, 501.5b-1
18" max.
B
Seal
18" max.
18" max.
Explosion-proof enclosure
Rigid conduit with threaded joints, 501.5 b-1
18" max.
Seal
Explosion-proof motor or one having no brushes or other arcing contacts, or resistors See 501.8-b
Rigid conduit or E.M.T.
Class I Division 2 Location

COMPARISON OF WIRING METHODS required by the NEC for motors in Divisions 1 and 2, Class I hazardous locations. Note the utilization of electrical metallic tubing to replace rigid conduit, and the location of a seal outside of the hazardous area, as an added safeguard against gas or vapor leaks in connections.

a three-lamp ballast for the cost of a two-lamp ballast. Better stroboscopic correction would result by having one lamp on each phase. A simple multiple-type capacitor mounted on the outside of the ballast would take care of power factor correction. Fixtures would then be made in multiples of three lamps instead of two as at present, materially stepping up light output with little change in present fixture layouts.

The merits of this suggestion for higher voltage branch circuits and operation of fluorescent lighting systems should be given careful consideration by the lighting industry as a whole. Acceptance of this theory may well mark a definite step in the future development of the lighting installations which will be designed in the near future.

There has also been some discussion about the use of high frequency circuits for fluorescent lighting operation. To date, installation of such systems has been confined primarily to aircraft lighting which is operated at 400 cycles. Research work on this problem is still being carried on in lighting laboratories on frequencies ranging from 200 to 1000 cycles. The main problem seems to be the development of an economical high-frequency generator (either rotary or inverter type) which might be installed ahead of the lighting distribution system as part of the overall wiring plan.

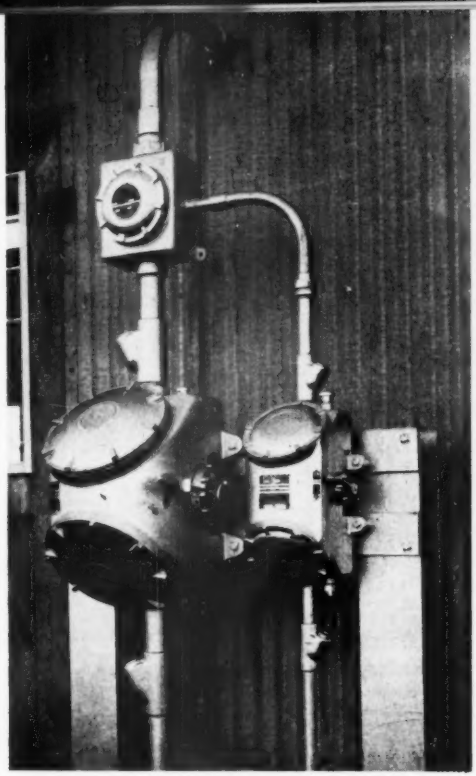
There is one possibility which might be considered in selecting a frequency. That is the combination of high frequency lighting distribution with high frequency distribution now used for high speed electric tools. Out of this research may come a development which will make the use of high frequency fluorescent lighting and high frequency electric tools economically attractive from the standpoint of necessary distribution facilities.

SPECIAL CIRCUITS

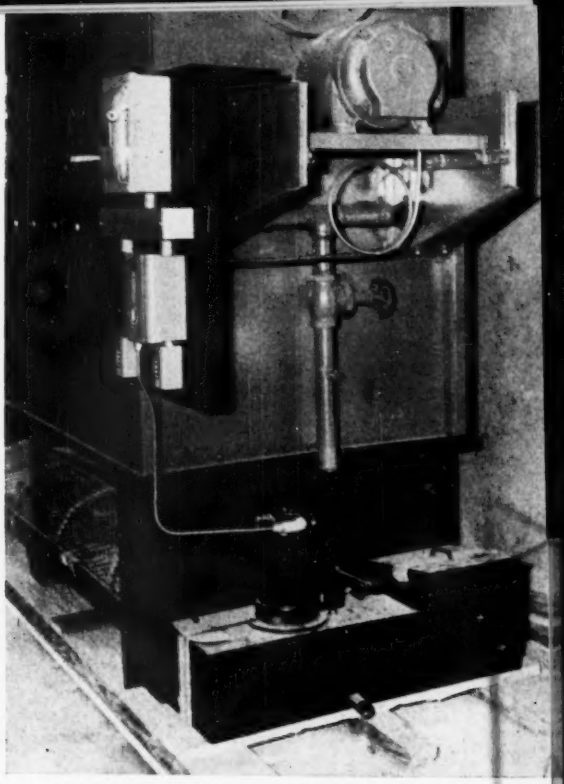
Practically every electrical installation involves some equipment which requires circuits different from the normal run of power and lighting connections. Such wiring may be classed as heavy duty or special circuits. Special receptacle circuits for grounded portable tools and electrical equipment are one example.

Circuits to electric welding equipment, both the arc and resistance type, require special consideration from the standpoint of design and installation. In fact, such circuits must generally be tailor-made for the specific equipment operation. Contractors and engineers should contact the user to determine, as fully as possible, how he is going to use the welder. Such factors as duty cycle, current surges, and type of material to be welded have very definite bearing on the circuit design.

Generally, high voltage feeders should serve the welding transformer bank. Secondary circuits from transformer to unit should be kept as short as possible to reduce voltage drop to an absolute minimum. Single-phase loads should be carefully balanced on the three-phase service. Equipment of this type generally has very low power factor—in the range of 40%. Hence, reactance loss in circuits to such equipment becomes an important factor. This can be reduced by using multiple-cable circuits and the use of nonmetallic raceways or conduits. Across-the-line capacitors will improve the power factor. Reduction of



BREATHER AND DRAIN plugs on these explosion-proof circuit breakers minimize trouble from moisture and condensation within the enclosures.



LOOPED CONNECTION between control and motor on this refrigeration installation is made with new mineral-insulated conductors (in copper sheath) as protection against moisture.

surge peaks on the circuit can be accomplished by use of series capacitors which store energy to take such peaks. These units are sensitive to change in material being welded and must be carefully adjusted for new materials—a chore for an experienced plant electrician.

Electric heating equipment of the infra-red lamp type is fed by conventional circuits. Banks of lamps for industrial application may be connected to circuits above 150-volts to ground if lampholders are rated at the higher voltage. Each section, panel, or strip of such heating equipment is considered a single "appliance" by the NEC and its terminal block is considered an individual outlet.

High frequency heating of the induction or dielectric type requires an electrical system entirely separate from the normal plant system. Co-axial cable feeders to heating units are becoming more common. Circuits to the motor-generators supplying the high frequency current, however, are connected to the power system in the normal manner. High frequency tools (360 cycles) are also on separate systems served by motor generators fed by the normal power system.

There are numerous other "special" circuit problems encountered in electrical system design and installation. Many of these can be solved by cable and equipment designed to fit the condition at hand. The alert contractor will carefully study manufacturer's literature on new developments and consult his representative when such problems arise.

Indicative of the mass of equipment available to the contractor is the different types of cables for moisture, oil, gasoline, and excessive heat conditions. Examples are the various types of synthetic insulations now on the market. Latest development in this respect is a newly announced, mineral insulated (magnesium oxide) cable with a copper sheath that will withstand excessive moisture and heat and needs no raceway when properly installed.

HAZARDOUS LOCATIONS

Wiring for hazardous locations is a science in itself. Materials, equipment and installation techniques used are quite definitely limited by the provisions of Article 500 of the 1951 National Electrical Code.

By definition, the Code classified hazardous areas into the following three categories:

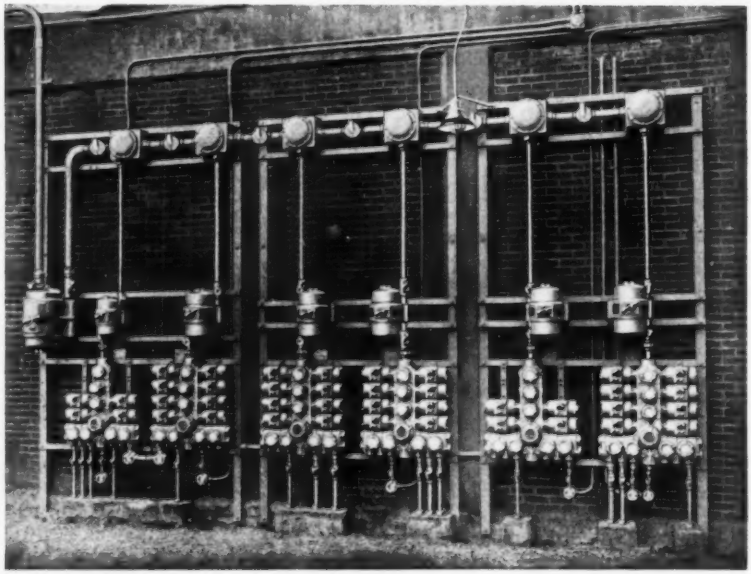
Class I—Locations in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitible mixtures.

Class II—Locations which are hazardous because of the presence of combustible dust.

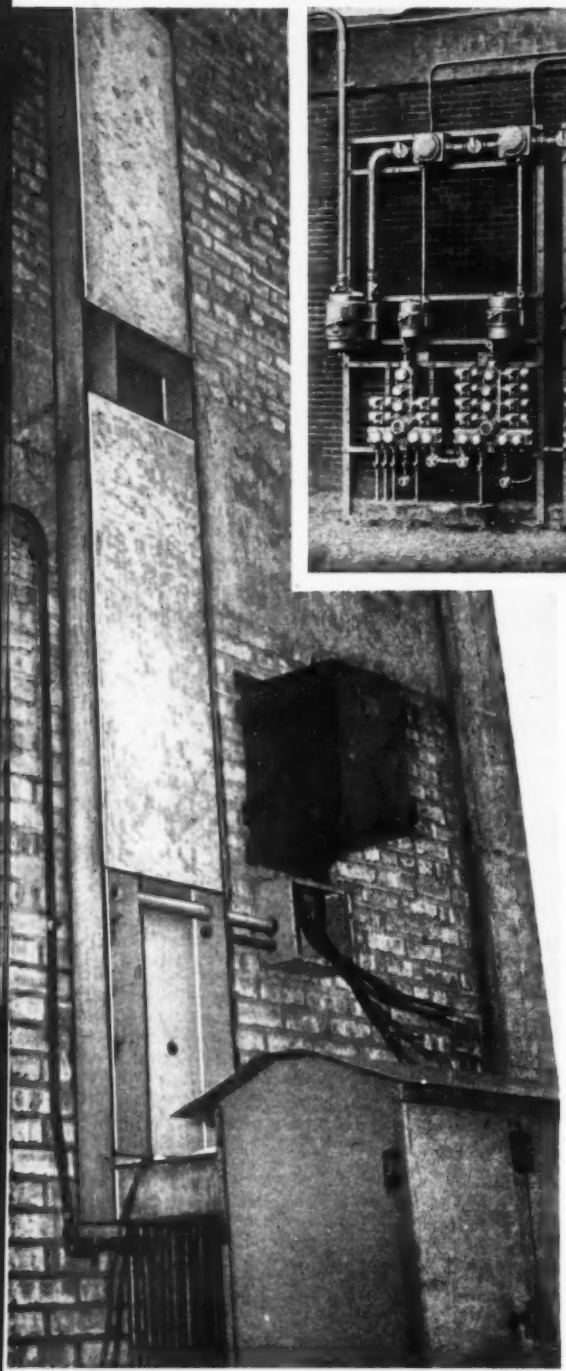
Class III—Locations which are hazardous because of the presence of easily ignitible fibers or flyings, but in which such fibers or flying are not likely to be in suspension in air in quantities sufficient to produce ignitible mixtures.

Each classification is further subdivided into two divisions: (1) where the hazardous condition is continuously present and (2) where the condition is not always present but there still exists the possibility of explosion or flash fire.

The type of equipment and wiring methods to be



EXPLOSION-PROOF MOTOR CONTROL center has banks of combination starters protected by circuit breakers. Conduit branches have drain-type inspection sealing fittings.



OUTDOOR INSTALLATION of power and lighting panel with partitioned riser trough to carry branch circuits to hazardous location within the building.

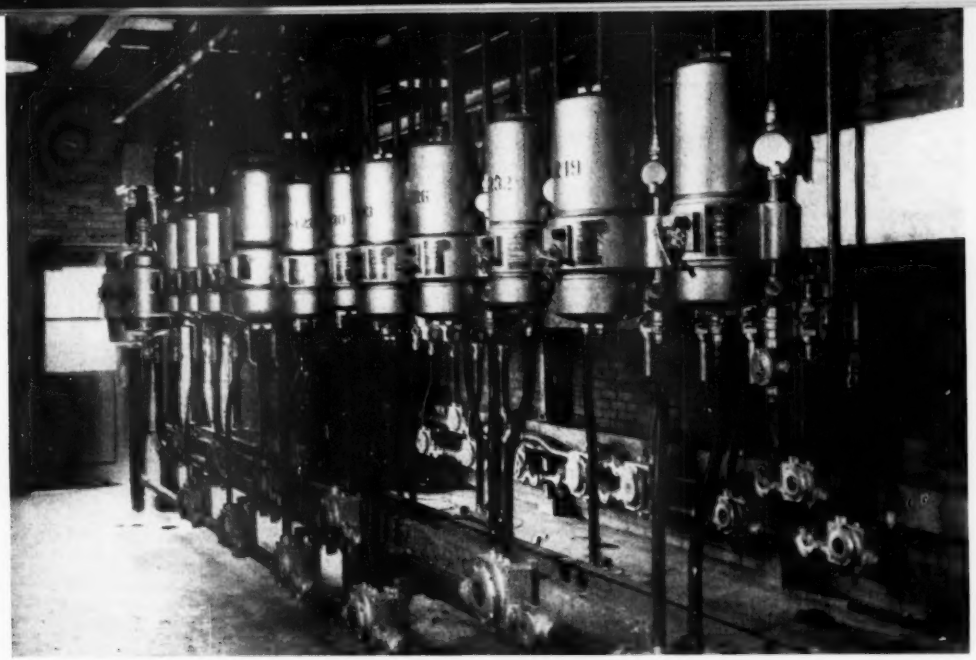
used under each classification are specifically defined in the Code regulations. The explosion-proof equipment mentioned has been designed and tested to withstand the explosion of a specific gas or vapor which may occur within it and to prevent ignition of the surrounding explosive atmosphere from any sparks, flashes or explosions within the equipment enclosures.

Wiring for Class I, Division I (flammable gases or vapors) locations must be in rigid conduit, and all outlet and junction boxes, switches, controllers and motors must be of *explosion-proof* design. Conduit runs must have sealing fittings (to prevent passage of gases, vapors or flames from one portion of the electrical system to another) not more than 18 inches from the point where the conduit enters enclosures housing equipment which may produce sparks, arcs or high temperatures. These fittings must also be installed in each conduit run of 2-inch or larger size when it enters enclosures housing terminals, splices or taps; also on all conduit runs where they leave the hazardous area to enter a non-hazardous area. All conduit and box connections must be of the threaded type.

Division 2 requirements are essentially the same as above for equipment (explosion-proof), but conduit may be either rigid or electrical metallic tubing with certain reservations (Art. 500, Sec. 5015 b-1 and b-2). Fixed lighting fixtures can be of the vapor-proof type.

Class II locations (combustible dusts)—Div. 1 requires wiring in rigid conduit with threated dust-tight fittings and boxes. Other equipment must also be of dust-tight design. In Div. 2 of this class, conduit may be either rigid or EMT.

Class II locations (combustible fibers and flyings)—Div. 1 and 2 require rigid conduit with threaded fittings and boxes capable of preventing escape of sparks or flames. Fixtures, switch and controller



LIGHTING CONTROL CENTER in a hazardous area. Explosion-proof lighting panels at bottom are fed by circuit breaker protected feeder at left and individual circuit breakers above each panel. Note extensive use of sealing fittings in conduit runs to prevent passage of vapor or gasses along wiring paths.

enclosures as well as motors must be of dust-tight construction.

Some measure of simplification in hazardous area wiring has been achieved during the last few years. Explosion-proof motors are now being manufactured with factory seals and are supplied with explosion-proof terminal boxes. Receptacles, conduit fittings, switch, circuit breaker and pushbutton enclosures are now furnished with integral sealing chambers. Other new designs feature lighter weight, smaller size and cooler operation for explosion-proof fixtures.

Of special interest to those contractors concerned with hospital operating room wiring has been the development of explosion-proof, factory-sealed switches and other equipment which can be installed in existing non-explosion proof wiring systems.

Adjacent areas

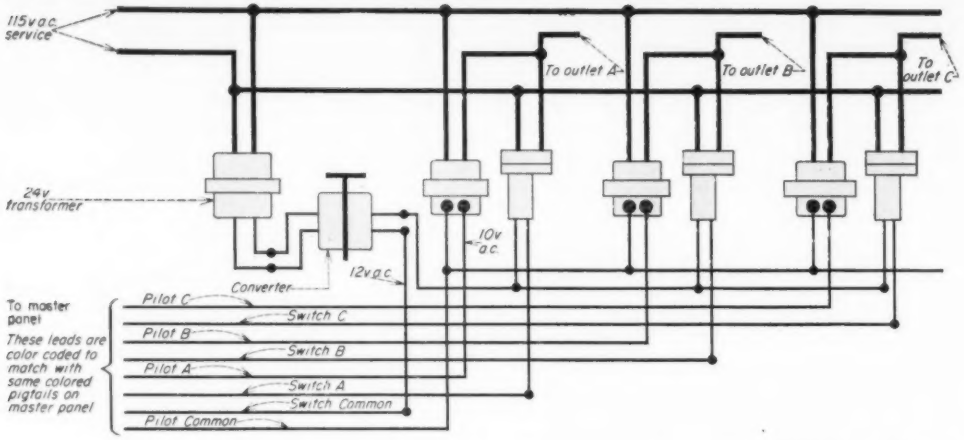
In hazardous area wiring, the general trend is to keep as much of the heavy equipment (starters, motors, switches, controllers, etc) in adjacent non-hazardous locations as is feasible. Thus the less expensive and less bulky standard items can be used. This gives the installing contractor and the engineer considerable latitude to exercise his ingenuity. In some installations, the distribution panel has been mounted in a weatherproof enclosure on the outer wall of the building and circuits run up the side of structure in a weatherproof trough. Only the actual motors, control pushbutton stations and fixtures of explosion-proof design were installed within the hazardous area.

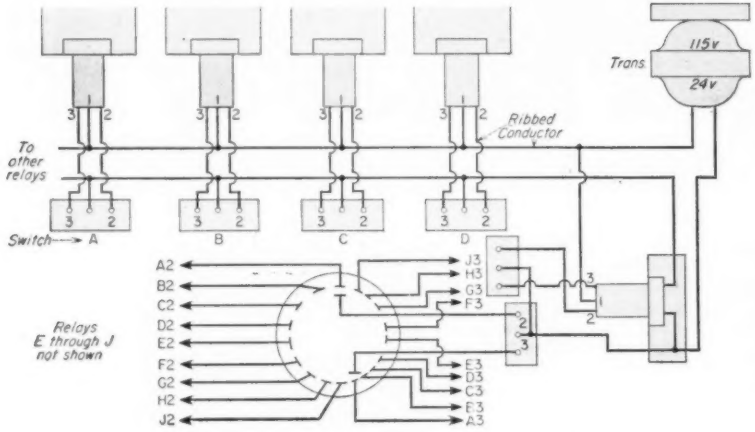
The use of drain plugs and breather plugs on explosion-proof motors and enclosures minimizes the problem of condensation and resultant possibility of short circuits. This condition becomes particularly acute where such equipment is installed outdoors (as in a refinery) and is subject to alternate heating and cooling. On lead-sheathed cable circuits, "wicking" action (seepage of condensation between insulation and sheath) is effectively prevented by sealing the cable ends at junction boxes with a coat of good quality lacquer applied to the exposed braid.

Extreme care must be exercised when handling and installing electrical equipment in hazardous locations. It should be stored away from dust and dirt. Fitting and enclosure covers should not be removed before installation. Machined and threaded surfaces should not be nicked or marred. All threads should be carefully aligned before the cover or bolt is tightened. A stripped thread may be disastrous in the event of an explosion within an enclosure. All threads on conduits and box connections must be made up tight with at least five threads engaged. Sealing fittings must be properly installed and carefully filled with sealing compound.

Since World War II, materials known to be hazardous have become increasingly prevalent in industry, and attempts to speed up production cycles through forced vaporization or higher temperatures have further increased the importance of considering hazardous conditions seriously.

Contractors who estimate and install wiring for hazardous locations should carefully check the class of hazard against the equipment listing; definitely ascertain from the owner what type of operation is to be carried on within the area in question; and finally check the design specifications and proposed installation layout with the local electrical inspection authority. This type of an electrical installation is expensive and there are no short cuts. A clear cut understanding of all requirements and installation methods must be had before material is ordered and the job is started.





HOOKUP DETAIL of Touchplate control units. Relays position on and off in sequence from momentary contact switches. Small transformers energized from the relay switch leg send low voltage back to pilots at master switch panel.

HOOKUP DETAIL of G. E. Remote Control. Relays position on and off by three wire momentary contact switches. Master control is a rotary selector switch. Relays are usually mounted at outlets but may be ganged in a central location.

Relay Switching

RELAY switching and low voltage control are gaining rapid momentum as a new and unique method of switching. Initial success in application to residential wiring has tended to obscure the fundamental and probably far reaching nature of the development.

The influence of relay switching on future wiring design can be compared with the past development of remote control circuits in industrial applications. Rather than merely replacing some existing conventional switching methods, relay switching opens up important new areas of switch control.

In essence, present low voltage switching consists of a relay switch inserted in the controlled circuit operating on a low ac or dc voltage, a low voltage momentary contact switch, a transformer (and rectifier if dc) and associated wiring, usually No. 18 in various groups.

For residential wiring, relay switching with simple and inexpensive circuits opens the way for extensive multiple point control of lighting equipment and appliances. Master switching, heretofore involving elaborate circuitry, is readily adaptable with simple components to conventional relay switching installations.

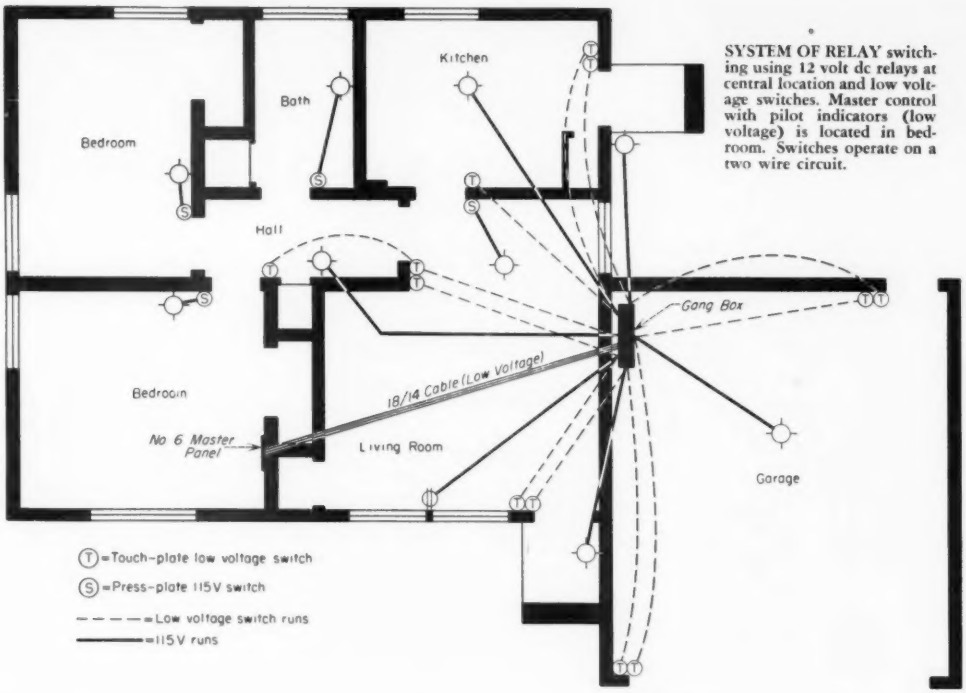
Main features of the relay switch system are:

Power supply: for ac, a centrally located transformer reducing voltage to 24 volts with 3 ampere current limit characteristics or approved overcurrent protection; for dc, a transformer and converter (rectifier and condenser) delivering 12 volts.

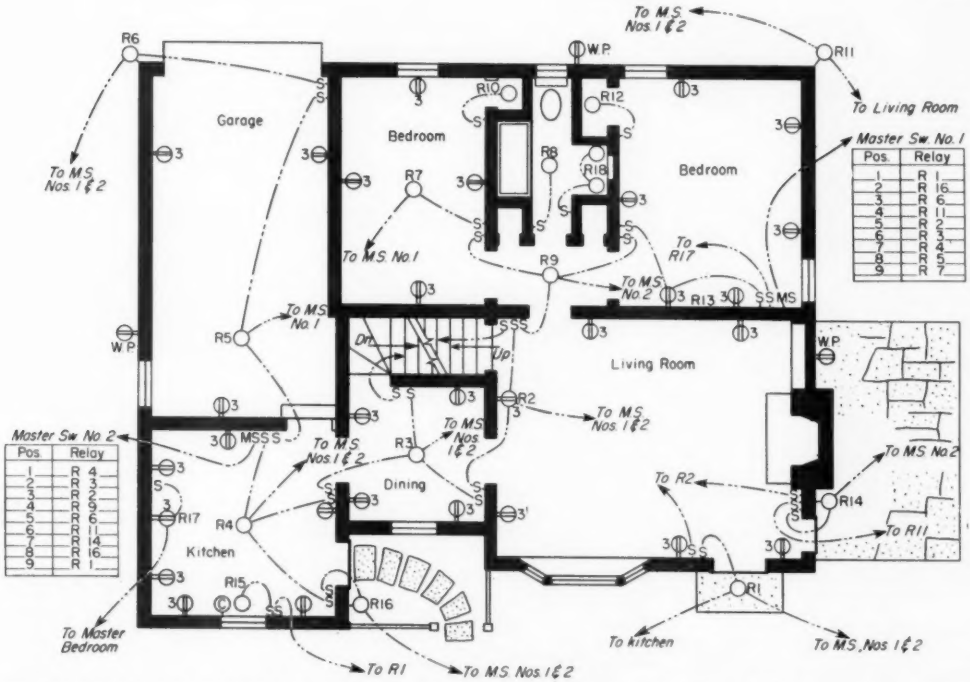
Switches: for two wire systems, a momentary contact switch with a large single button in a plate of conventional size; for three wire systems, a rocking pushbutton or a tumbler type silent switch normally centered and pressed up for on, down for off.

Relays: for dc, a sequence on-off relay designed for outlet box or central control unit installation; for ac two wire control, a sequence on-off relay; for ac three wire control, a two position solenoid switch also designed for outlet box or central control installation.

Master Controls: for three wire system, a rotary selector switch selects the light or circuit to be operated by an adjoining switch. By holding the switch in the on or off position and rotating the selector all lights can be switched at once. Another type of rotary switch is motor driven, sweeping all circuits when the control switch is operated. For two wire system, a compact pushbutton group of six (or twelve) buttons of plastic material are trans-illuminated with pilot lamps.



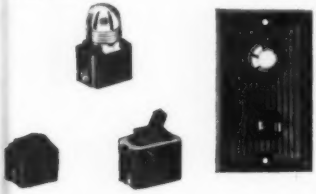
SYSTEM OF RELAY switching using 12 volt dc relays at central location and low voltage switches. Master control with pilot indicators (low voltage) is located in bedroom. Switches operate on a two wire circuit.



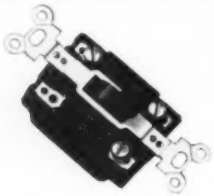
SYSTEM OF RELAY switching using 24 volt ac relays at outlets and low voltage switches. Master control is provided by a multiple position switch. Switches are on a three wire circuit and are indicating on and off.

SOME WIRING COST-CUTTERS

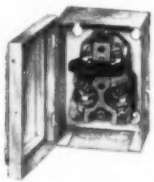
BACK-WIRED DUPLEX outlet accepts all appliances. Back-wiring cuts installation time, gives positive connection every time.



INTERCHANGEABLE LINE affords numerous attractive gangs. Simplifies wiring and saves material. A complete assortment of plates, outlets, switches, bell pushes and others is available.



NEW BACK- OR TOP-WIRED switch is quick and easy to put in. No wire bending or looping necessary. All connections positive.



ENCLOSED SWITCHES, pull-out or front-operated types. Positive acting mechanisms for utmost safety. Quality units in quality enclosures.

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Labor-saving is of prime importance to the contractor today. Yet the reputable contractor will never sacrifice ***quality*** in order to cut labor costs.

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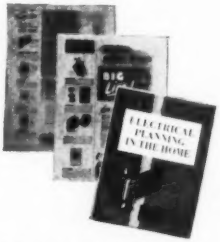
So promote adequate wiring, and these — ***quality*** wiring devices that do a ***better*** job ***faster***, on every job.

Through messages like these, we're reminding architects of the importance of adequate wiring and wiring devices to everyone in the building field.



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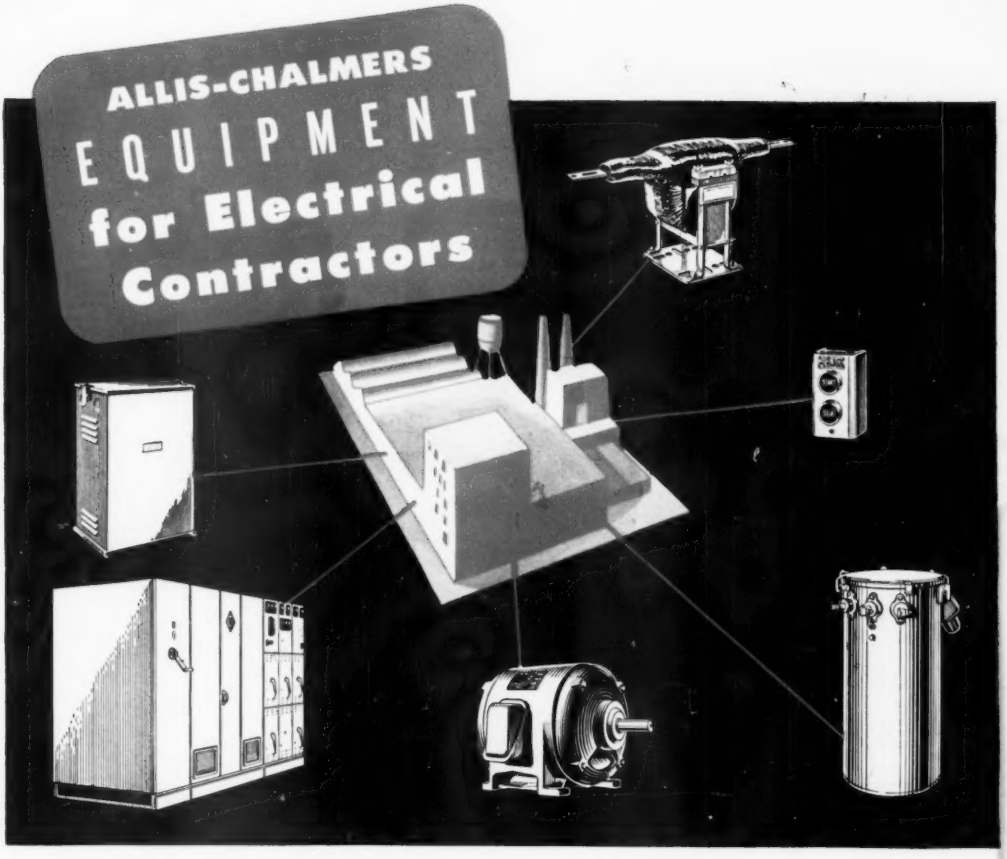

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ALLIS-CHALMERS

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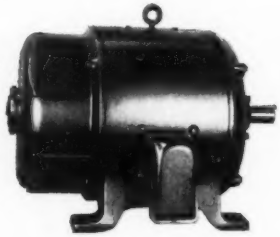
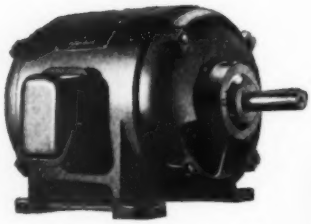
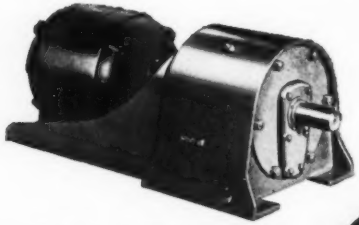
Motors



Direct Current Motors for loads requiring speed adjustment

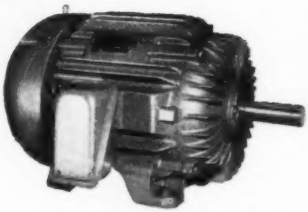


AP — Open Drip-Proof Squirrel Cage Induction Motors



Gearmotors — with motors of any mechanical or electrical modification

APV — Vertically mounted motors



APZ — Totally enclosed Fan-Cooled motors

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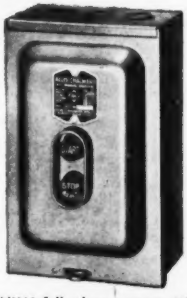
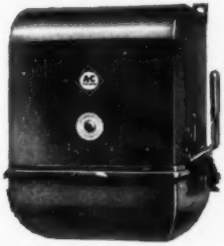
ALLIS-CHALMERS Motor Starters

COMBINATION full voltage starters —NEMA sizes 0 through 5 for motors to 200 hp on voltage of 550 or less.

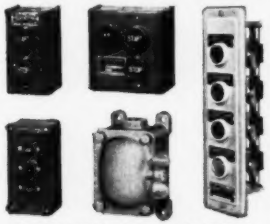


MANUAL full voltage starters. NEMA sizes 0 and 1 in general purpose or special enclosures.



MANUAL reduced voltage auto-transformer starters. General purpose or special enclosures provided.

MAGNETIC full voltage starters. NEMA sizes 0 through 7 for motors to 600 hp at 550 v or less.



PUSH BUTTON CONTROL STATIONS. Used with magnetic starters in remote control arrangements for starting, stopping and reversing operations.

Wide Selection, Durable Construction and Safety-First Design

THERE IS AN Allis-Chalmers starter to control *any* motor, including squirrel cage, synchronous and wound rotor types . . . regardless of size.

Allis-Chalmers starters are generously designed, durably built. Many protective features are incorporated, such as: overload, undervoltage, and interlocking devices. In addition, Allis-Chalmers broad application experience means the right starter for your job. A-C engineering experience covers every major industry. Call your nearby A-C Authorized Dealer or Sales Office, or write Allis-Chalmers, Milwaukee 1, Wis.

A-34428

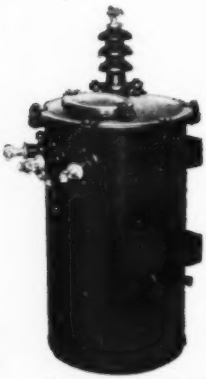
ALLIS-CHALMERS

"You can control <u>any</u> motor with an Allis-Chalmers motor starter"

ALLIS-CHALMERS Distribution Transformers

DISTRIBUTION transformers 100 kva and below. Typical of 2400 and 4800 volt classes.

DISTRIBUTION transformers 100 kva and below. Typical of 7200 through 14,400 volt classes.



DISTRIBUTION transformers 25 kva and below. Typical of 7200 and 7620 volt classes for grounded WYE operation with low voltage of 120/240.

ALLIS-CHALMERS Dry Type Transformer

LARGER CAPACITIES, single and three phase are ordinarily built for indoor operation, but can be supplied for outdoors on special order.

10 KVA and smaller, single phase; 30 kva and smaller, three phase. Wall mounted, indoors or out.

Get High Efficiency . . . Safety . . . Low Maintenance . . . Long Life

ALLIS-CHALMERS distribution transformers are built in one of the most modern plants in the industry and incorporate the latest developments for long life and low maintenance. Tank is of heavy gauge steel. Cold rolled electrical steel is used in cores to reduce size and weight. *Spra-Bonderizing* provides long lasting protection for the tank surface. These are but a few of the many features.

Allis-Chalmers builds a complete line of transformers including protected (ACP Transformers) and conventional designs.

For more details, ask your nearby A-C District Office, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

Cut Copper — Reduce

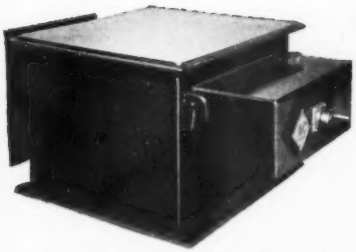
WHEN RELOCATING machinery, bring power close to the load with Allis-Chalmers dry type transformers. Secondary feeders are thereby kept short. This prevents efficiency losses due to under-voltage operation—saves on copper conductors. Shop men find these transformers small and easy to handle.

Pioneers in Power and Electrical Equipment from Generation through Utilization

ALLIS-

ALLIS-CHALMERS

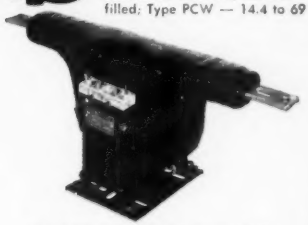
Instrument Transformers



SEALED DRY TYPE transformer utilizes class H insulation materials. Gives complete protection against flooding, dusty or corrosive atmospheres, explosion and fire . . . ideal for hazardous industrial applications.

COMPACT CORE AND COIL. "Fiberglas" and other Class B insulating materials are used. Coils impregnated to make them impervious to moisture and protect against dirt.

METERING OUTFITS, outdoor — oil filled; Type PCW — 14.4 to 69 kv.



INDOOR CURRENT, for heavy duty metering; Types K2E — 8.7 kv, and K3E — 15 kv.

INDOOR POTENTIAL, Type PD, fused or unfused; 200 VA up to 14,400 v.

OUTDOOR POTENTIAL, Type SPW, for line-to-line operation. Standard ratings with standard insulation class ratings of 69 kv.

Requirements Power Losses!

In addition, simple clamp-type connectors speed hook-up time. They are a standard feature on 15 through 50 kva single phase and 37½ through 100 kva, three phase units. Case is *Spra-Bonderized*, triple-coated with baked-on paint. Ask your nearby A-C District Office for details, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

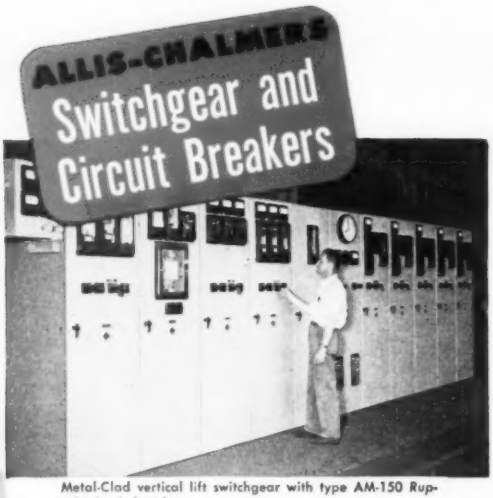
Over 400 Ratings Fit Most Design Needs

WHETHER YOU NEED metering outfits, or current or potential transformers, either indoors or out, you can get them from Allis-Chalmers. Uniformly high accuracy and liberal reserve thermal capacity are built-in qualities. Coils approximate the circular shape, prevent distortion under heavy overcurrents.

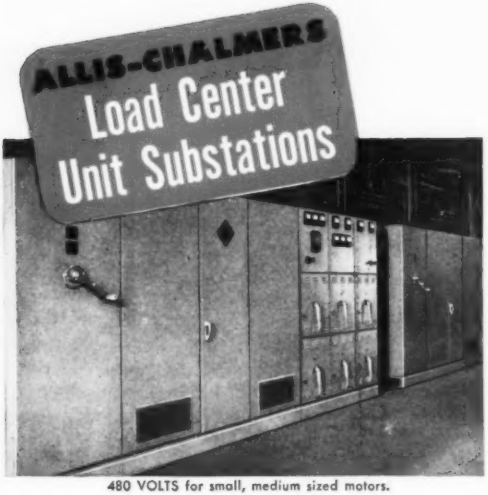
The Allis-Chalmers standard line fills practically every power need. Special designs built to meet unusual applications. For details call your nearby district office, or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-3442C

CHALMERS

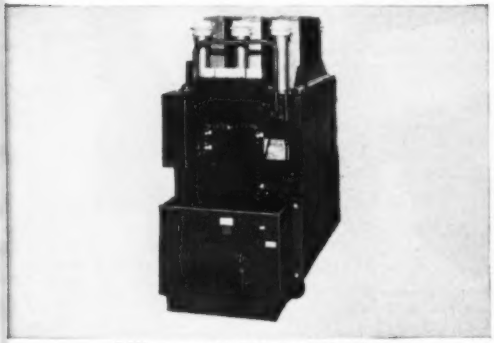
A-C ALLIS-CHALMERS



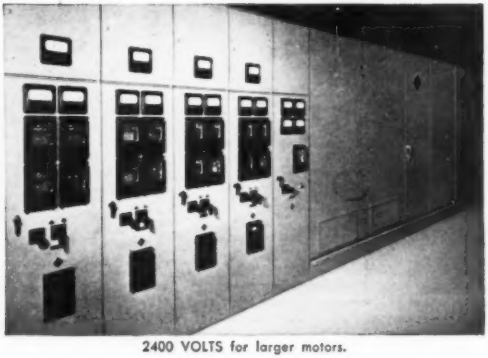
Metal-Clad vertical lift switchgear with type AM-150 *Ruptair* circuit breakers.



480 VOLTS for small, medium sized motors.



2,000 Ampere AM-250B *Ruptair* breaker.



2400 VOLTS for larger motors.

Dependable Electric Power Safeguards Production

YOUR DEMANDS for switching and protective equipment can be met by Allis-Chalmers . . . whatever they may be. Low first cost and quick installation are attained by using standard designs wherever possible. Yet specific engineering is provided each installation in order to select, arrange and group the various components for best efficiency.

Both switchgear and circuit breakers meet all NEMA and ASA standards of safety and performance. They arrive factory assembled complete with accessories and ready to operate when delivered. Safety features include fully automatic shutters, positive interlocks and isolated component parts.

Standard switchgear is available in indoor and outdoor types for voltages up to 13,800 volts. Interrupting capacity of circuit breakers for metal-enclosed switchgear is 15,000 to 100,000 amperes. Breaker ratings for standard metal-clad switchgear is from 50,000 to 500,000 kva.

Ask your nearby A-C District Office for complete information, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

Load Center Unit Substations Pay Off in Lower Installation Cost

ALLIS-CHALMERS load center unit substations are designed for easy handling and assembly on the job. Pre-tested units are shipped in assemblies as large as you can handle. You will save time and money by installing Allis-Chalmers unit substations.

Call an Allis-Chalmers engineer during the basic planning stage to examine the problem; type of load, density, cost and availability of equipment, installation and maintenance costs. Take advantage of the experience of these engineers!

You can either phone your nearby A-C representative, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

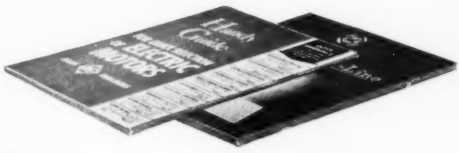
Ruptair is an Allis-Chalmers trademark.

A-3442D

ALLIS-

Pioneers in Power and Electrical

ALLIS-CHALMERS Literature



MOTORS

Guide to Selection of Electric Motors	51B6052
Totally-Enclosed Fan-Cooled Motors	51B7225
Care of Electric Motors	51B6229

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Across the Line Manual and Magnetic	14B7132
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SWITCHGEAR AND CIRCUIT BREAKERS

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Low Voltage Metal Enclosed Switchgear	18B6376
Switchgear and Control Devices	25B7095
Modernize Your Breakers	71R6415

***TEXROPE* DRIVES**

Handy Guide to Quick Selection	20B6051
Pre-Engineered Constant Speed *Texrope* Drives	20B6956
Pre-Engineered Variable Speed *Texrope* Drives	20B7499

Send Now For this Useful Literature!

Whether you're planning a new installation or modernizing an old one, this helpful Allis-Chalmers literature is yours for the asking. Simply call your nearby A-C district Office, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

Texrope is an Allis-Chalmers trademark.

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A-3442E

ALLIS-CHALMERS

Pioneers in Power and Electrical Equipment from Generation through Utilization

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ABC ARMORED CABLE

Has These Improved Features Which Make Installation *EASIER—QUICKER—SAFER*

Bond Strip Under Armor

Permanently low armor resistance **is provided in sizes No. 14 and 12 AWG by use of a flattened, bonding wire which is in contact with the under side of each convolution.**

Prefabricated Break Lines

The Cut Mark (at 1½" intervals) shows the location of a prefabricated breaking line inside the armor. Only a few strokes of a file or saw guided by the Cut Mark are required to cut through one outer ridge, and a bend by hand severs the armor. This results in a clean separation with no sharp edge—a safer, easier and faster job. The prefabricated breaking lines are so designed that there is *no reduction* in tensile strength, bending quality, crushing resistance and electrical conductivity of armor.

FILE OR SAW

BREAK

PULL OUT PAPER

INSERT BUSHING

In the last 20 years alone, over SIX BILLION FEET of Armored Cable have been produced by the industry. Armored Cable provides the only general purpose, factory-assembled and tested, metal protected wiring system.

CRESCENT WIRE & CABLE

CRESCENT INSULATED WIRE & CABLE CO.
TRENTON, N. J.

"400 Amp. Ordinary Fuses Required Switches Too Big For Our Space . . . . But FUSETRON dual-element FUSES in 200 Amp. Switches Left Us Room to SPARE."
W. L. Davidson. Chief Electrical Engr.
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"When we were revamping five 3 phase 220 volt motor circuits, each feeding a 25 h.p. and a 15 h.p. motor, at our Fairfax plant — we found we were short of room for the 400 amp. main switches required by ordinary fuses.
"By changing to Fusetron dual-element fuses, however, we were able to use 200 amp. switches and have room to spare.
"The installation has proved very satisfactory, and in addition, we get better protection because the motors are fused nearer to the operating load."
(FUSETRON is a trade mark of the Bussmann Mfg. Co., Division of McGraw Electric Co.)
FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

You Get 10 Point Protection by changing to

Fusetron DUAL-ELEMENT Fuses

1 * Protect against short-circuits.

2 Protect against needless blows caused by harmless overloads.

3 Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.

4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5 Protect motors against burnout from overloading.

6 Protect motors against burnout due to single phasing.

7 Give DOUBLE burnout protection to large motors — without extra cost.

8 Make protection of small motors simple and inexpensive.

9 Protect against waste of space and money — permit use of proper size switches and panels.

10 Protect coils, transformers and solenoids against burnout.

*Fusetron Fuses have high interrupting capacity as shown by tests of the Electrical Testing Laboratories of New York City in December 1947.

Here's Why You Get This All-Purpose Protection

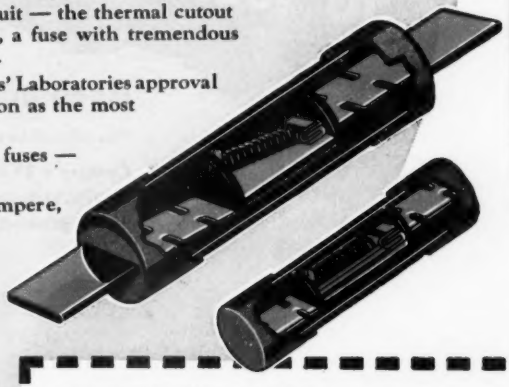
The fuse link element opens on short-circuit — the thermal cutout element protects on overloads — the result, a fuse with tremendous time-lag and much less electrical resistance.

They have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to the same dimensions as ordinary fuses — fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere, both 250 and 600 volt types. Also in plug types for 125 volt circuits.

Their cost is surprisingly low.



Don't Risk Losses!

One **needless** shutdown . . .
One **lost** motor . . .
One **destroyed** switch or panel . . .
One **burned out** solenoid . . .

May cost you far more than replacing every ordinary fuse with a Fusetron dual-element Fuse.

Mail the Coupon Now!

Bussmann Mfg. Co., University at Jefferson
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Please send me complete facts about FUSETRON dual-element Fuses.

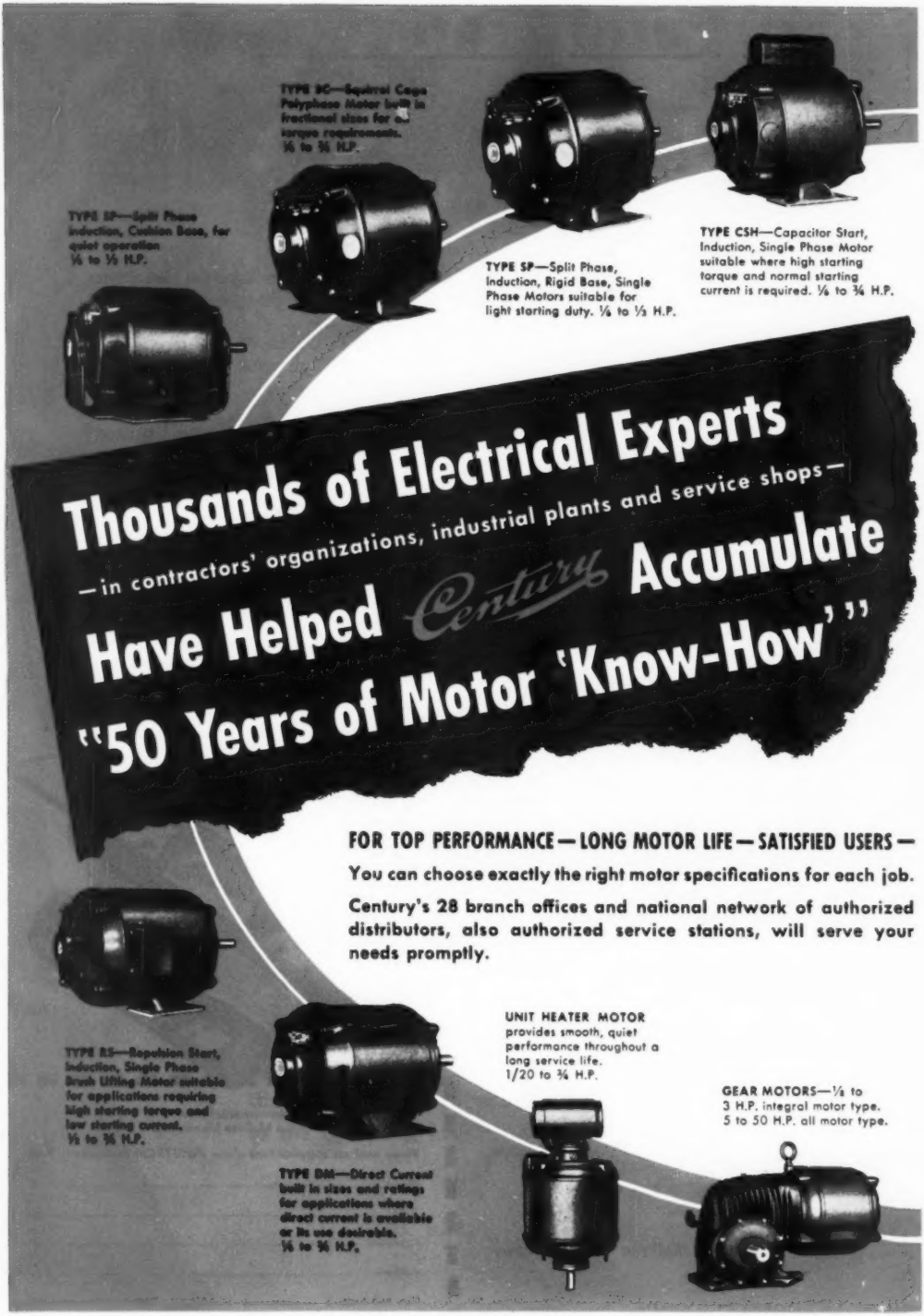
Name .....

Title .....

Company .....

Address .....

City and Zone ..... State ..... ECM 751


TYPE SC—Squirrel Cage Polyphase Motor built in fractional sizes for all torque requirements. ⅛ to ½ H.P.
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TYPE SP—Split Phase, Induction, Rigid Base, Single Phase Motors suitable for light starting duty. ⅛ to ½ H.P.
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—in contractors' organizations, industrial plants and service shops—
Have Helped Century Accumulate
"50 Years of Motor 'Know-How'"
FOR TOP PERFORMANCE—LONG MOTOR LIFE—SATISFIED USERS—
You can choose exactly the right motor specifications for each job.
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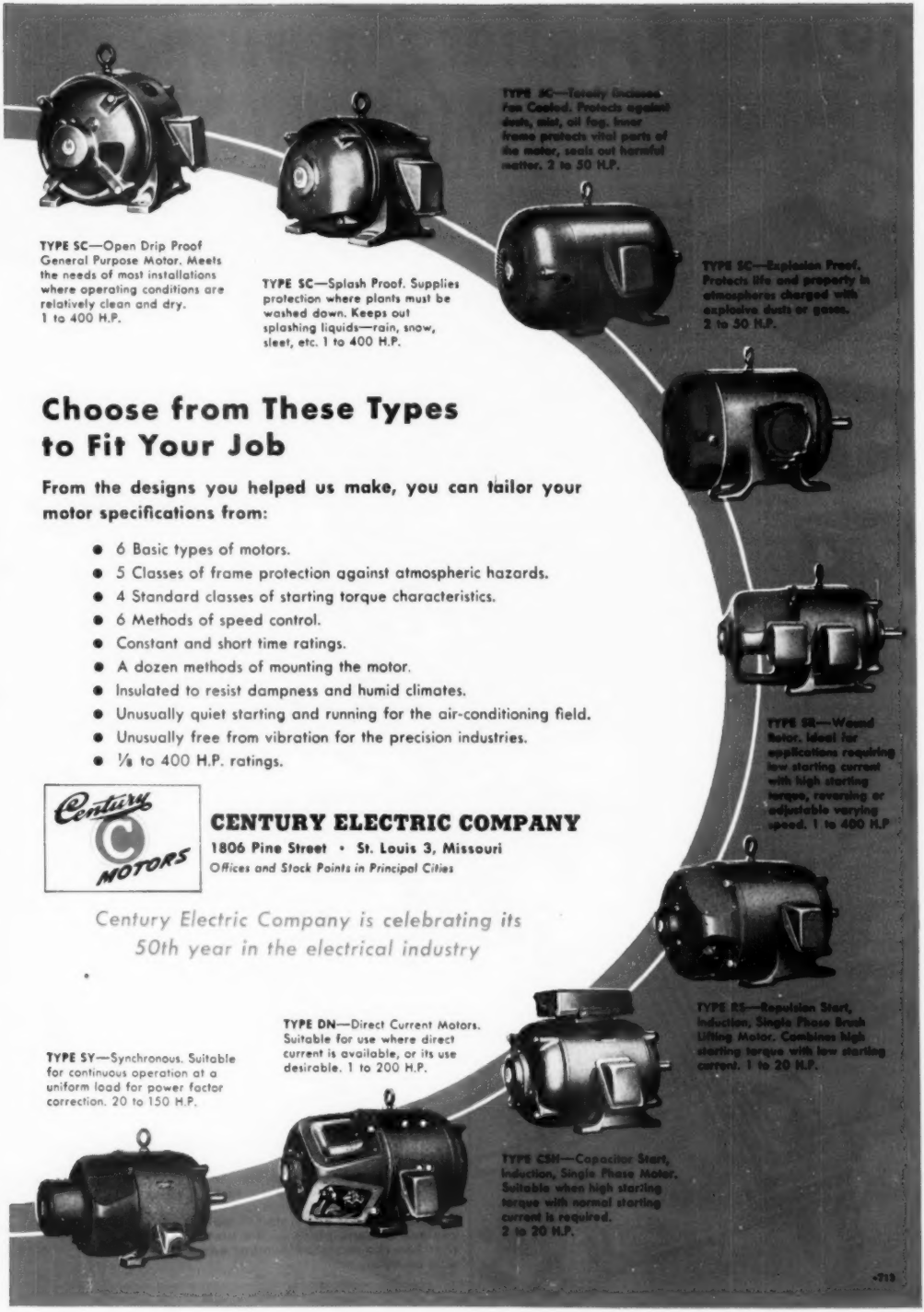
GEAR MOTORS—⅛ to 3 H.P. integral motor type. 5 to 50 H.P. all motor type.
TYPE DM—Direct Current built in sizes and ratings for applications where direct current is available or its use desirable. ⅛ to ¾ H.P.


TYPE SC—Open Drip Proof General Purpose Motor. Meets the needs of most installations where operating conditions are relatively clean and dry. 1 to 400 H.P.
TYPE SC—Splash Proof. Supplies protection where plants must be washed down. Keeps out splashing liquids—rain, snow, sleet, etc. 1 to 400 H.P.
TYPE SC—Totally Enclosed Fan Cooled. Protects against dusts, mist, oil fog. Inner frame protects vital parts of the motor, seals out harmful matter. 2 to 50 H.P.
TYPE SC—Explosion Proof. Protects life and property in atmospheres charged with explosive dusts or gases. 2 to 50 H.P.
TYPE SR—Wound Rotor. Ideal for applications requiring low starting current with high starting torque, reversing or adjustable varying speed. 1 to 400 H.P.
TYPE RS—Repulsion Start, Induction, Single Phase Brush Lifting Motor. Combines high starting torque with low starting current. 1 to 20 H.P.
TYPE CSH—Capacitor Start, Induction, Single Phase Motor. Suitable when high starting torque with normal starting current is required. 2 to 20 H.P.
TYPE DN—Direct Current Motors. Suitable for use where direct current is available, or its use desirable. 1 to 200 H.P.
TYPE SY—Synchronous. Suitable for continuous operation at a uniform load for power factor correction. 20 to 150 H.P.

Choose from These Types to Fit Your Job

From the designs you helped us make, you can tailor your motor specifications from:

- 6 Basic types of motors.
- 5 Classes of frame protection against atmospheric hazards.
- 4 Standard classes of starting torque characteristics.
- 6 Methods of speed control.
- Constant and short time ratings.
- A dozen methods of mounting the motor.
- Insulated to resist dampness and humid climates.
- Unusually quiet starting and running for the air-conditioning field.
- Unusually free from vibration for the precision industries.
- ⅛ to 400 H.P. ratings.

Century C MOTORS

CENTURY ELECTRIC COMPANY

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Century Electric Company is celebrating its 50th year in the electrical industry

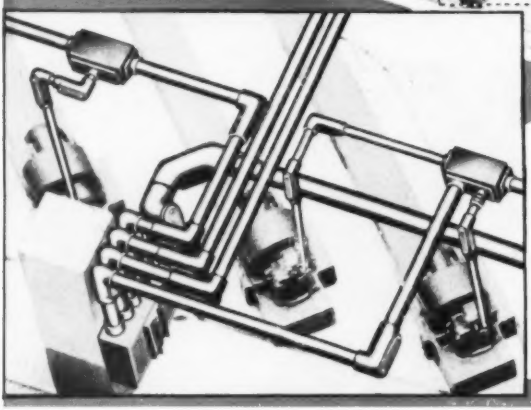
for NEW frontiers in wiring . . .

the conduit and CONDULET*

RS Series Junction Condulets take detachable hub plates with 1, 2, or 3 hubs for conduit from ½" to 3½".

THE "NEW LOOK" IN CONDULET INSTALLATION

A model of a screw machine department with a modern layout of cast Feraloy Condulets and rigid conduit. It has flexibility plus all the other Condulet advantages. The actual installation has been in service for several years and is highly satisfactory.

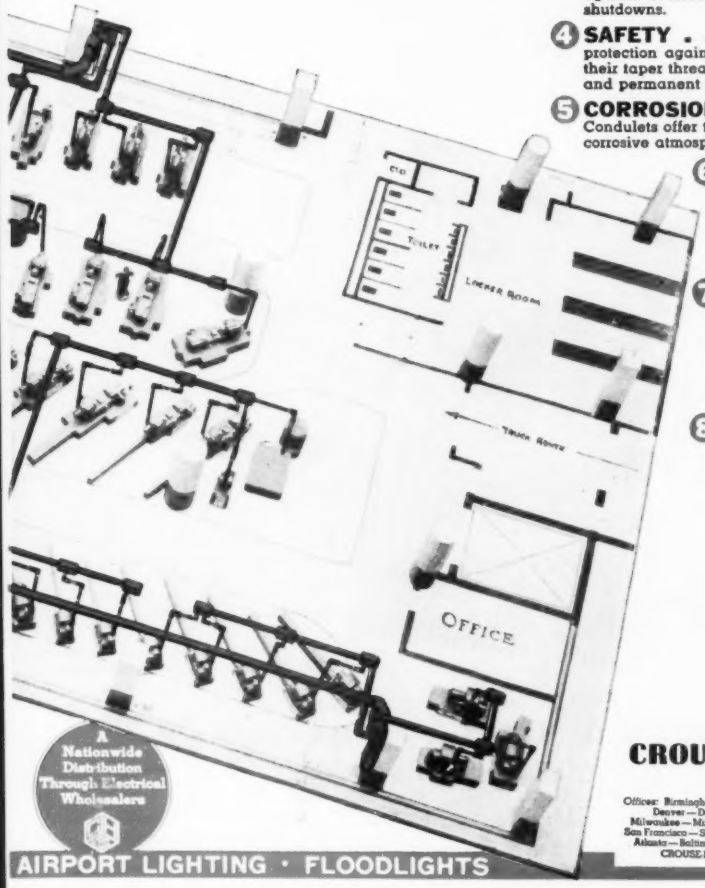


Enlarged view, showing how Type RSM Condulets provide for easy expansion . . . branch circuits can be added at any time. Simply replace a blank plate with a plate that has the required number and size of hubs.

CONDULETS · TRAFFIC SIGNALS

method gives YOU definite advantages!

NEW ways of using the familiar Condulet and conduit material have produced outstanding results. Modern installation layouts meet industry's modern needs for flexibility while retaining the enduring protection and safety that can only be given by cast Feraloy Condulets and rigid conduit.



1 FLEXIBILITY . . . A modern Condulet installation, like the one illustrated below, provides for the vigorous growth and changing conditions of a modern industry. The RS Series Condulets with their detachable hub plates make it easy to change circuits or add additional circuits at any time.

2 UNIVERSAL APPLICATION . . . Galvanized Condulets and galvanized rigid conduit may be used under all atmospheric conditions and occupancies.

3 MECHANICAL PROTECTION . . . Cast Feraloy Condulets and rigid conduit provide the best possible protection against accidental damage to the wiring — prevents costly shutdowns.

4 SAFETY . . . A Condulet installation gives maximum protection against personal injury and fires. Condulets with their taper threaded hubs and rigid conduit provide a reliable and permanent low resistance path to ground.

5 CORROSION RESISTING . . . Cast Feraloy Condulets offer the best protection wherever moisture, dust or corrosive atmospheres are present.

6 ECONOMY . . . Direct comparison of Condulet and rigid circuit installations with other wiring methods show comparable installed costs. The durability, safety, and low maintenance cost of Condulet installations produces savings which pay dividends over the years.

7 QUALITY . . . All Condulets are built to Crouse-Hinds' high standard of quality with painstaking care by skilled craftsmen. Thousands of Condulet installations that are still in active service after twenty, thirty, forty or more years offer positive proof that the trademark CONDULET stands for reliability and long life.

8 VARIETY . . . Thousands of types and sizes of Condulets, plugs and receptacles, and lighting fixtures are listed in the Condulet Catalog, including a complete explosion-proof and dust-tight line for use in hazardous locations. There is a Condulet for every purpose.

On your next electrical layout, whether modernization or new construction, plan to get all of the benefits of sturdy cast Feraloy Condulets and rigid conduit. Send for additional information on modern Condulet installation.

*CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.

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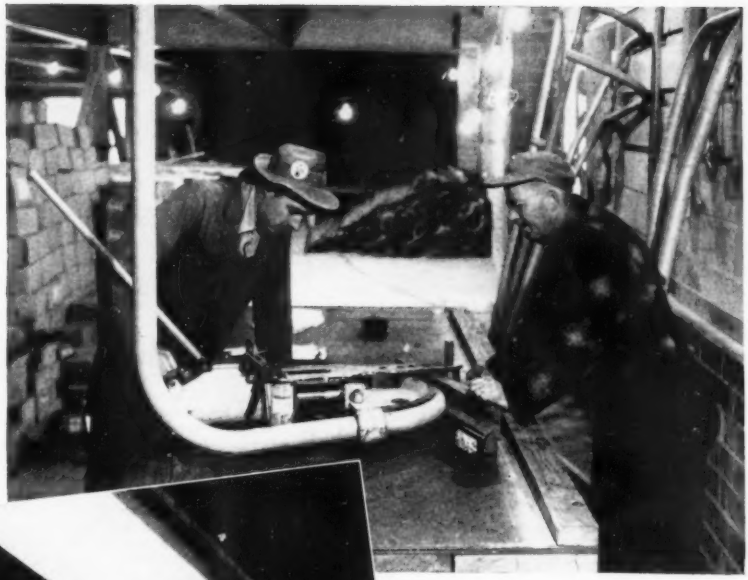
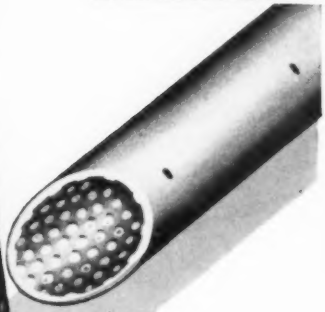


Hydraulic bending of large-diameter ELECTRUNITE E.M.T. *for intallation in a large West Coast central power station.*

Wire it



Runs of large-diameter and small-diameter ELECTRUNITE E.M.T. *in a well-known industrial plant producing electrical parts.*

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with ELECTRUNITE E.M.T. ...and forget it...

● Add years of maintenance-free life to the electrical systems of modern buildings . . . install modern, light-but-strong ELECTRUNITE E.M.T. steel raceways. It's the cost-cutting way to assure safe, trouble-free wiring systems for tomorrow and the years to come. Fully protects wires from fire, moisture, and mechanical damage.

Journeymen like the ease of working with ELECTRUNITE E.M.T. It's easy to bend ELECTRUNITE E.M.T. smoothly and accurately . . . uniform metal structure and exclusive inch-marking on the popular sizes assure workmanlike bends. It's easy to pull wires through ELECTRUNITE E.M.T. . . . exclusive inside knurling on the smaller sizes provides millions of friction-free bearings for conductors. Erection costs are kept within budgets.

Threadless, concrete-tight couplings provide easy-to-fit connections . . . no thread-cutting, no turning the whole length of raceway to tighten joints.

ELECTRUNITE E.M.T. is inspected by Underwriters' Laboratories, meets the National Electrical Code for exposed, concealed, and concrete slab construction.

Let us show you how ELECTRUNITE E.M.T. can cut wiring costs, help you maintain construction schedules.

Work WITH your ELECTRUNITE distributor.. tell him your E.M.T. requirements as far ahead as possible. Increased demand and D.O. requirements for popular E.M.T. may temporarily deplete his stocks in the sizes and quantities you need. But he'll fill your order as promptly as possible from his share of the E.M.T. we are allotted the steel to make.

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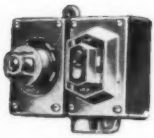
REPUBLIC STEEL

LIGHTWEIGHT THREADLESS RIGID STEEL RACEWAY

CONDULETS . . .

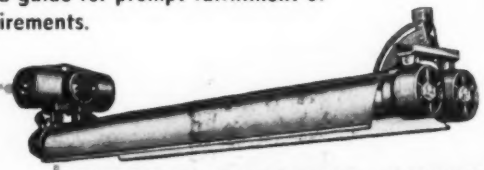
"In one day it's on its way to any part of the country."



If you want to get that important project finished on time call on us to supply the proper type of Crouse-Hinds Condulets direct from our warehouse. We can give you fast expert service because of our convenient midwest location; our extensive stocks; our intimate knowledge of the Crouse-Hinds line; and our wealth of past experience in providing contractors with these materials for thousands of jobs in the oil industry, the chemical industry, governmental projects, and the like.

We specialize in explosion-proof equipment, such as fixtures, both incandescent and fluorescent, motor control equipment, junction boxes, unions, switches, flexible couplings, and sealing fittings.

Write us today on your company letterhead for a copy of our catalog and we will also send information which will serve as a guide for prompt fulfillment of your Condulet requirements.



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REPRODUCTION OF 24" X 36" WALL CHART FURNISHED TO DISTRIBUTORS WHO STOCK AUSTIN CLUSTER LIGHTS

Packaging makes the Difference!

That's why the Austin Line is easier to stock, saves order filling time, and cuts handling costs!

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Take the easily recognized Austin labels—they're specifically designed for fast, positive identification. On every inner carton and outer carton label, in exactly the same relative position, the QUANTITY, SIZE, AUSTIN CATALOG NUMBER, PRODUCT DESCRIPTION and ILLUSTRATION are boldly and clearly printed. No chance for error—no time lost in searching for obscurely labeled stock! Universal catalog numbers always included on label when applicable.

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Carefully designed and sturdily made for the express purpose of keeping Austin products in their original excellent condition from factory to user. Stout metal-edge corners run to full carton height as insurance against collapse, and to enable safe, easy storage of stock. Shipping containers are built of the finest corrugated boxboard, with bottoms steel stapled and tops glued with silicate soda for maximum protection.

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Confidence in the Product you Sell
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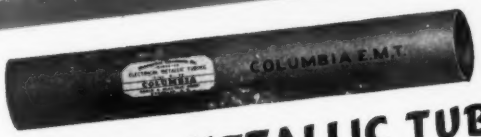

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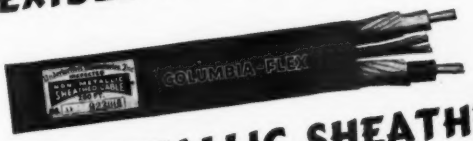
A. B. C. ARMORED CABLE

FLEXIBLE STEEL CONDUIT



NON-METALLIC SHEATHED CABLE

ALL COLUMBIA electric products are Approved by Underwriters Laboratories

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EXPANDING

LOOK AHEAD WITH

1. Q. *HOW CAN WIRING MATERIALS BE SAVED WHEN POWER CABLE MUST BE RE-LOCATED?*

A. G-E Interlocked-armor cable does the trick, because it's cable and raceway in one flexible assembly. Put it up as a permanent or temporary circuit and you can take it down intact any time. Just reel it in, move it to the new location, and put it up again. You'll find G-E Interlocked-armor easy to work with. And, it's a time and material saver.

2. Q. *DO YOU KNOW THIS TWIST FOR FASTER ROUGHING-IN?*

A. When you're installing a switch box on wood studding, just nail the box directly to the stud through nail holes in the box. It will save you time—eliminate hanging accessories. Simply drive a ten penny nail right through the nail holes on the outside plate of a G-E Levelock switch box, and the job is done. Or, use the extra set of nail holes on the inside plate for ease in gang mounting Levelock boxes.

3. Q. *HOW CAN YOU HELP BUILDING OWNERS AND TENANTS TO AVOID DELAYS WHEN OFFICE LAYOUTS ARE CHANGED?*

A. Recommend G-E Fiberduct raceways for new buildings . . . for electrical modernization. This underfloor wiring system permits telephone, power, and signal outlets to be repositioned readily. All that is necessary is to drill a hole anywhere along the Fiberduct raceway and install the outlet.

4. Q. *WHAT SWITCH SHOULD YOU SELECT FOR NEW RESIDENTIAL 20 AMP CIRCUITS?*

A. Now that 20 amp circuits for all convenience outlets are permitted in residential wiring jobs, you can go right to work with G-E heavy-duty switches. You can get G-E heavy-duty switches for 20 amp duty in 125 v and 250 v ratings. Available in single or double pole; three way; and single pole, quadruple break.

ELECTRIC SERVICE?
THESE 7 G-E WIRING FACTS

5. Q. *HOW CAN YOU APPLY G-E REMOTE-CONTROL WIRING TO INDUSTRIAL LIGHTING PROBLEMS?*

A. Provide selective control of blocks of lights to facilitate working operations in offices, warehouses, storerooms, and garages. Place G-E remote-control switches at area entrances and strategic control locations. At loading platforms give complete control of lighting with G-E remote control. For plant protective lighting systems consider a control center at the guardhouse and at points where firemen enter the building; also, local selective control at any area entranceway.

6. Q. *WHY CAN AVA CABLES CARRY AS MUCH AS 64% MORE CURRENT THROUGH EXISTING RACEWAYS?*

A. The reason is this: AVA Deltabeston* cables are doubly insulated with heat-beating asbestos and varnished cambric. This tough jacket makes it possible for AVA cables to operate effectively at higher ambient temperatures. That's why at normal ambient temperatures AVA cables can carry as much as 64% more current than ordinary wires.

7. Q. *WHY DOES G-E RIGID CONDUIT MAKE WIRE PULLING SO EASY?*

A. It's smoothness that does it. All G-E conduit has a glassy smooth coating of Glyptal* lacquer inside as well as outside. This smooth surface makes wire pulling easy—speeds up the job.

General Electric Construction Materials Division at Bridgeport is a headquarters for wiring progress

Through constant research and precision manufacturing methods, the General Electric Construction Materials Division sets the pace for the electrical industry with modern and high-grade wiring materials.

Through distributors in every locality and specialists in the local G-E offices, the G-E Construction Materials Division offers you complete service on any type of wiring problem.

For information on any G-E wiring material, contact your local G-E Construction Materials distributor, or write Section K61-718, Construction Materials Division, General Electric Company, Bridgeport 2, Connecticut.

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You can put your confidence in—

GENERAL ELECTRIC

PRODUCTS . . . that are helping Industry meet today's Production goals!

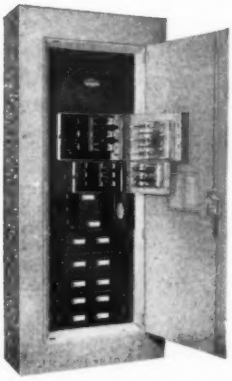
• Production demands that are almost fantastic are being made on American Industry today. To meet the staggering quotas that have been set for it, Industry must rise to new peaks of production efficiency.

Electrical products bearing the Ⓕ trade-mark are playing a vital role in this new era of greater productivity. All along the production line — from power source to machines — Ⓕ products are serving the power and light distribution needs of Industry . . . and serving it well.

Heading the list is the famed Ⓕ SWITCHBOARD — the result of more than 60 years of electrical manufacturing experience. A record of quality workmanship and design that reflects itself in such features as safety, service and performance — these modern, efficient power centers are built in three types — the Ⓕ SHUTLBRAK, Ⓕ KLAMPSWITCHFUZ and Ⓕ CIRCUIT BREAKER.

Built from standard pre-assembled units to meet exact specifications — these sturdy switchboards provide all the advantages of "tailor-made" assemblies, while retaining the savings of standardized equipment.

Ⓕ Shutlbrak



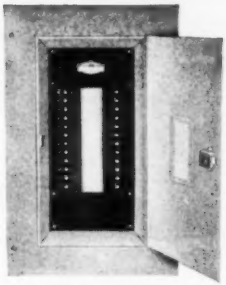
Ⓕ Feeder Panelboard

Ⓕ Power Plugin Busduct

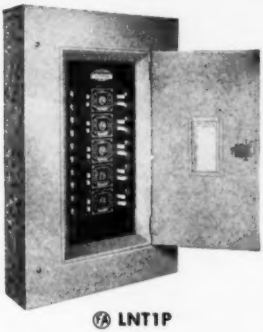
From sub-station to switchboard to machines, power is being distributed by FEEDER Ⓕ BUSDUCT, the modern, efficient and economical method of distributing heavy current. To give even greater flexibility to industry's electrical distribution system, Feeder Ⓕ Busduct, has been designed to team up with Ⓕ POWER PLUGIN, (Plugin Busduct), the efficient compact system of power distribution. By providing convenient plug-in outlets every foot of the way, Ⓕ Power Plugin affords a ready power source for new or present equipment anywhere along the production line.

Another Ⓕ Product that is bridging the power gap from power source to machines is the Ⓕ FEEDER PANELBOARD. This compact, panelboard is unexcelled for the distribution of current through assemblies of standardized switching units, either pull-out or hinged pull-out types, operating switch or circuit breaker types.

Ⓕ Column Type

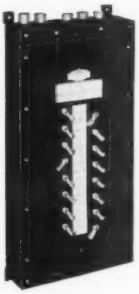


Ⓕ Quicklag



Ⓕ LNT1P

A variety of dependable panelboards for light distribution is also manufactured by Ⓕ. These include the Ⓕ LNT1P type with tumbler switch and plug fuse branches and "sequence bussing" for better balance of load . . . Ⓕ THERMAG or Ⓕ QUICKLAG or AB CIRCUIT BREAKER types for automatic, fuse-less circuit protection . . . Ⓕ COLUMN TYPE to mount between the flanges of "H" columns and save space on the job . . . and Ⓕ DUSTITE for sealing out the hazards of carbon black, coal or coke dust, grain dust and other hazardous dust conditions.



Ⓕ Dustite

At the end of the power line, Ⓕ SHUTLBRAK SWITCHES have proven ideal as individual operating switches for motor disconnect. They are front operated, horsepower rated industrial switches with quick made and break operation and interlocking fuse doors that permit access to fuse compartment only when switch is "Off". (A special release is provided for authorized persons.)

Ⓕ Shutlbrak Switch

So all along the production line, Ⓕ products are serving definite needs

Should you have a power and light distribution problem, the chances are that Ⓕ can provide products that will help you solve it. A coast-to-coast organization of Sales Engineers will gladly furnish latest engineering data on Ⓕ Products or render a complete survey and report on specific electrical problems . . . all without obligation, of course. Contact your nearest Ⓕ Representative (he's listed in Sweet's) . . . or, if you prefer, write direct to Headquarter's Office for information on Ⓕ PRODUCTS.

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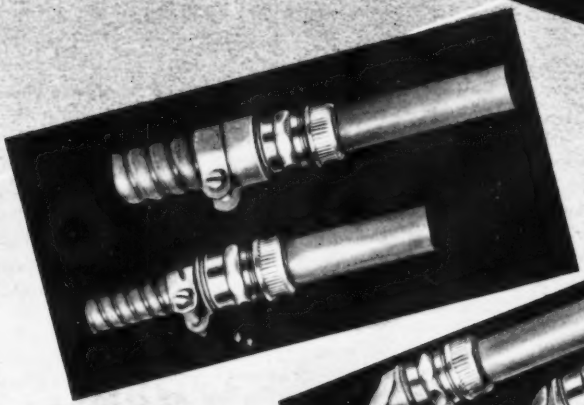
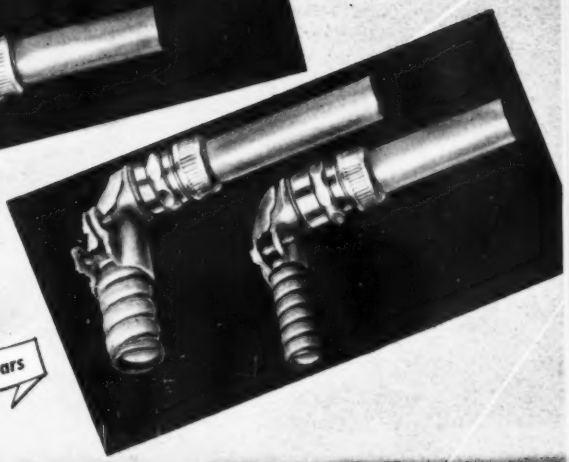
Our 60th Year

Fitting PROGRESS

for New Frontiers •





MW

manufacturers for over 30 years

The U-Com coupling was developed to allow great flexibility in connecting thin wall to rigid conduit, flexible conduit, or armored cable. Just one example of its extreme versatility is the ease with which it permits a run from thin wall to flexible steel conduit in wiring-in the power for a machine tool.

The U-Com coupling is a Mid-century fitting development with true "New Frontiers" possibilities. The surface for new applications has scarcely been scratched.

And this development is typical of the Midwest organization. At every step in fitting manufacturing operation—from design, production, inspection to distribution, delivery, and customer service—you will find Midwest quietly in tune with electrical industry's needs and progress.

MODERN FITTINGS FOR

• thinwall conduit • rigid conduit • metallic and non-metallic cable • flexible steel conduit • service entrance cable • grounding devices • lighting fixture fittings

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NATIONAL ELECTRIC

CONDUIT SYSTEMS

SHERARDUCT—Full weight, threaded, rigid steel conduit *fortified* against rust and corrosion by the "Sherardizing" process for *life-time* protection.

XDUCT JUNIOR—Electrical Metallic Tubing. Electro-galvanized, then further protected inside by a *smooth,* lustrous coating of clear, durable enamel.

FLEXSTEEL—Galvanized, flexible-steel conduit. Continuous runs from outlet to outlet reduce installation costs. Provides an economical "pull-in pull-out," grounded system.

NEPCODUCT—The *steel* underfloor duct system that provides convenience outlets at the floor *surface.* For power, lighting, telephone and signal service *in any type of floor construction.*

BUS SYSTEMS

LO-LOSS FEEDER BUS

Highest transmission efficiency due to low voltage drop with all types of load. Recommended for long feeder runs.

STANDARD FEEDER BUS TYPE "A" HOUSING

For normal runs between transformer bank and switchgear equipment. Housings for both indoor and outdoor installations.

I. P. I. "PLUG-IN" BUS

For branch runs from feeder bus. Plug-in openings, staggered on 15-inch centers on two sides, permit insertion of devices *every* 7½ *inches.*

FOR ALL SYSTEMS

NE insulated building wires and cables, connectors, boxes and accessories to meet the requirements of any wiring job.

All Products Listed by Underwriters' Laboratories, Inc.

Sold through leading electrical wholesalers

WIRING SYSTEMS Engineered to Fit the Job

WIRED SYSTEMS

NON-METALLIC SHEATHED CABLES

CANVAS BACK LOOMWIRE—A new, small diameter non-metallic sheathed cable with "frosty-finish" that is *cool, clean, slick, flexible.*

NE-O-PRENE LOOMWIRE—The *first* Neoprene-sheathed Loomwire to be listed by U/L. For wet locations, stables, farm buildings—where rot, fungus, moisture, ammonia-laden air and drastic weather conditions are destructive to other *approved* wiring.

A. B. C. ARMORED BUSHED CABLE—Complete, ready-to-use *grounded* wiring system. Sizes 14 and 12 have low-resistance grounding strip. Furnished with "Dilec Safecote" insulated wires.

PLUG-IN STRIP—"Constant Service" 2-Wire and "Switch-controlled" 3-wire multi-outlet assemblies. Outlets every 18″ or 6″. For residential or commercial use.

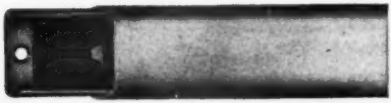
3-Wire PLUG-IN STRIP provides *wall-switch control* for lamps, *plus constant service* for clocks, radios, electric blankets and appliances. Each receptacle—a choice of two services.

RACEWAY SYSTEMS

XTENSIONDUCT—For extending circuits along walls and ceilings. Made with the "lay-in" feature. *No wire fishing necessary.* Attach the base, lay-in the wires, snap on the capping.

FLORDUCT

For across-the-floor service. Bump-proof, mop-proof, trip-proof—another NE raceway with the "lay-in" principle.



METAL MOLDING—For main lighting distribution and multiple branch circuits—also has the "lay-in" principle.

SURFACEDUCT—A 2-piece, all-purpose industrial "lay-in" raceway for every type of service up to 60 amp. Accommodates all manufacturers' approved devices.

4×4 WIREWAY—A hinged-lid steel wireway for feeders, branch circuits, control and signal wiring up to 600 volts. Speeds power rewiring. Eliminates exposed wiring hazards.

Everything in wiring points to NE

National Electric
PRODUCTS CORPORATION

1301 CHAMBER OF COMMERCE BLDG., PITTSBURGH 19, PA.

You can't buy Better Fittings or ones that cost less to use

Cross Section Showing Indentations.

Quicker to use and neater in appearance, Briegel All-Steel Indenter Fittings not only make stronger connections but also make each job more profitable to the contractor and satisfactory to his customers.

Two Easy Squeezes and they're set to stay. It is only natural that the Briegel All-Steel Indenter Fittings are the most widely used E.M.T. connectors and couplings. Contractors the world over recognize their cost cutting qualities and the fact that they make each wiring job neater, stronger and better.

All B-M Fittings Carry the Underwriters Seal of Approval

BRIEGEL METHOD TOOL CO.

GALVA, • ILLINOIS

It's New! It's Different! It's Easier to use!

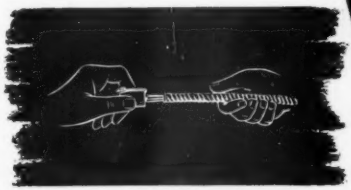
SnapX

PAT. APPLD. FOR

The Entirely New Connectors For Armored and Non-Metallic Cable That You Just Snap Into Place!

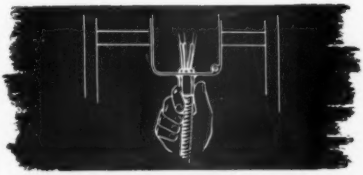
SNAPX is the new cable connector that is installed without tools. There are no nuts or screws to tighten. Just compress, snap it in place and it's set.

To try it is to buy it. See how easy SNAPX is to use! Write today for your free sample, giving the name and address of your electrical wholesaler.

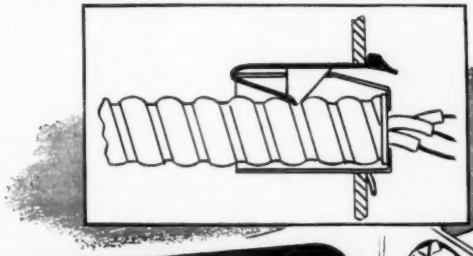


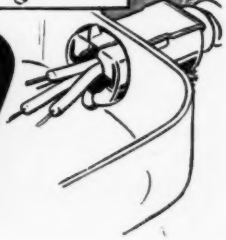
INSERT cable in **SNAPX** connector.

COMPRESS spring clip that holds cable.



SNAP IN to box knockout and the cable is set — the job done!





BRIEGEL METHOD TOOL CO.

GALVA, ILLINOIS

SnapX Fittings for 2-12 and 3-12, 2-14 and 3-14 armored, and 3-12 and 3-14 non-metallic cable carry the underwriters seal of approval.

Cables run COOLER...
in TRANSITE DUCTS

... reducing copper losses

... increasing current capacity

... prolonging insulation life

HERE'S HOW to reduce copper losses ... increase current carrying capacity ... and prolong insulation life—run your cables in Transite* Ducts.

Current carrying capacities can be increased in a typical duct bank as much as 5%, or I^2R losses can be reduced 11%, for cables located in Transite as compared with other ducts used for power circuits.

And, Transite Ducts assure permanent duct banks because Transite is incombustible; is immune to rust and rot; is unaffected by electrolysis; will not slag under action of an arc, and will retain its high original strength.

An unusually smooth bore assures no injury to cable sheath, either in natural movement under load, or when pulling-in cables. Long, lightweight lengths can be quickly and economically installed. In addition, a full line of fittings simplifies even the most complicated of installations.

For full information on Transite Ducts, write for Data Book DS-410. Johns-Manville, Box 290, New York 16, N. Y.

*Reg. U. S. Pat. Off.

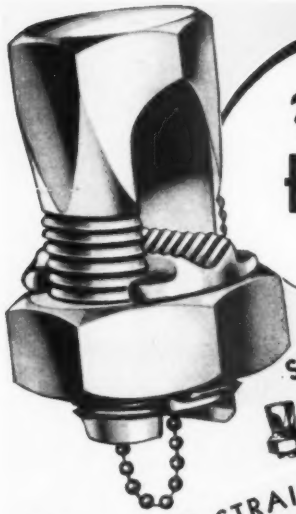
How Transite Ducts increase current carrying capacities

Type cable 3 cdr. 500 MCM Compack Sector, 15 KV (6th Edition AEIC Spec.)
No. of cables—3 (all loaded in one bank)
Daily Load Factor—75%
Earth Temp. ambient—20 C

	Transite	Other
Total Therm. Res. to Dielectric Loss (C watts/ft.)	5.66	6.17
Total Therm. Res. to Copper Loss (C watts/ft.)	4.44	4.95
Temp. Rise from Dielectric Loss (C)	1.9	2.1
Allowable Rise for Copper Loss (C)	59.1	58.9
Allowable Watts per ft. cable	4.44	3.96
Allowable Current—(Amps. per cdr.)	386.	365.
Allowable Current—(Relative %)	105.6	100.

Johns-Manville *Transite Ducts* "KORDUCT"— for encasement in concrete

"CONDUIT"— for use exposed and underground without encasement



You can find the

EXACT FITTING

you need — in the

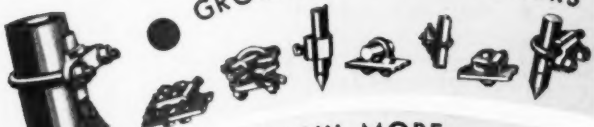
SERVICE CONNECTORS

STRAIGHT CONNECTORS

TEES

LUGS

GROUNDING CONNECTORS



and MANY MORE

PENN-UNION Catalog

The conductor fittings shown here can only suggest the wide variety. You'll find practically every good type, in a complete range of sizes.

New connectors are constantly being added - - so when you need a special fitting for an unusual service, tell us about it. Most likely we have exactly what you want.

Better design is a Penn-Union feature that you'll appreciate. For example, note the large gripping surfaces for wrenches, on the service connector shown in the upper left corner. When you use any Penn-Union fitting, you are sure that it is dependable - - mechanically and electrically.

Preferred by Leading Users, who have found that the "Penn-Union" mark on a connector is their best guarantee of unfailing service.

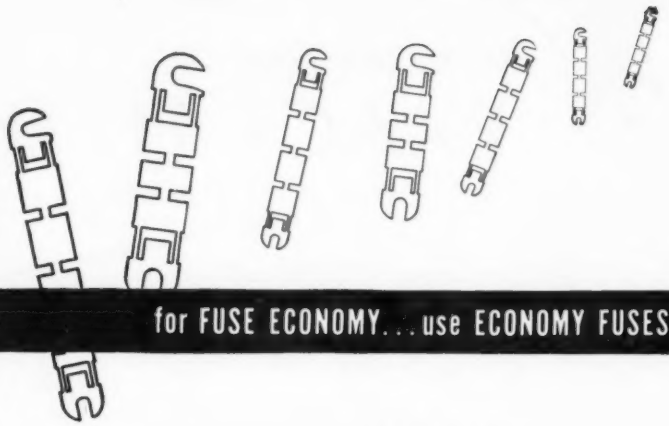
Sold by Leading Wholesalers

PENN-UNION ELECTRIC CORP.
ERIE, PA.

Canada: Dominion Cutout Company, Ltd., 250 Richmond St. West, Toronto

THE *Complete* LINE OF CONDUCTOR FITTINGS

PENN-UNION



for FUSE ECONOMY... use ECONOMY FUSES

SUREST protection at LOWEST cost

...and CONSERVES *precious Brass and Copper*

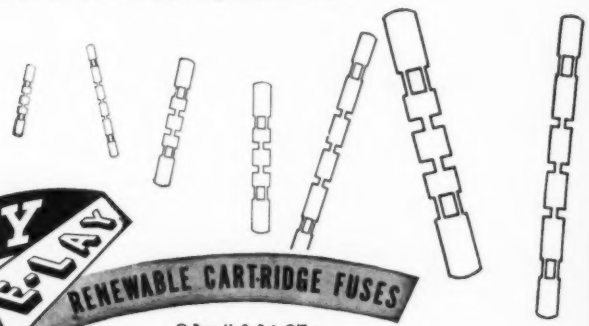
Your first investment in a metal-conserving "ECONOMY DE-LAY" Renewable Fuse is reasonable—and you save a lot of money every time you have a "blow". Because you simply remove the blown link and replace it with a new, inexpensive "ECONOMY DE-LAY" Renewal Link in the same cartridge.

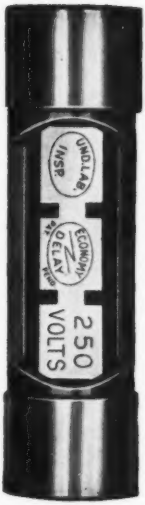
This restores the fuse to its original efficiency, at a cost of only a few cents for each "blow".

You can't buy any other type of fuse protection that "serves" you so well, and costs so little.

Your Electrical Wholesaler has "ECONOMY DE-LAY" Renewable Fuses and Renewal Links in stock.

Ask for the ECONOMY *Catalog and Price List.*





ECONOMY DE-LAY RENEWABLE CARTRIDGE FUSES

© Reg. U. S. Pat. Office

ECONOMY FUSE AND MFG. CO., 2717 GREENVIEW AVE., CHICAGO 14, ILLINOIS REPRESENTATIVES IN ALL PRINCIPAL CITIES

BUS DUCT IS FLEXIBLE

For Fast Tool Change-Over...

A Plug-In Every Foot

Here are two big jobs Westinghouse Bus Duct can do for you. One . . . provide a secondary power distribution system that is quickly and economically installed. Two . . . provide power at the point of use that is flexible for change-overs at any time.

Prefabricated sections of Westinghouse Duct, in any required length (10-foot maximum), are convenient to handle and mount. Ordinarily difficult or tight layouts are no problem with standardized tees, elbows and cross-overs. Simply suspend with cantilever hangers and bolt units together.

Plug-in receptacles every foot speed machine tie-ins, simplify the job of changing over or adding to production lines—without changing the distribution system. No wire mazes to unravel. No cable to splice. To relocate duct, just dismantle, rearrange, remount. All equipment is salvageable. Production line down time is held to a minimum.

For the full story, call your Westinghouse distributor, or write for Manual B-4272-A, Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania.

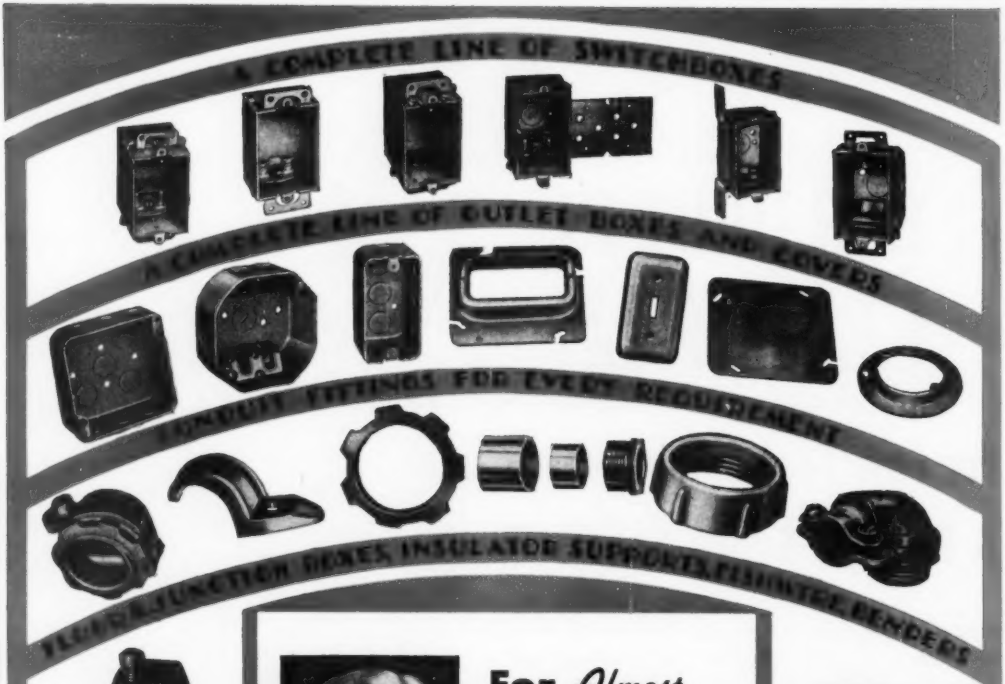
J-30060

YOU CAN BE SURE.. IF IT'S

Westinghouse

BUS DUCT

DESIGN TESTED AND VERIFIED IN THE Westinghouse HIGH POWER LABORATORY


A COMPLETE LINE OF SWITCHBOXES
A COMPLETE LINE OF OUTLET BOXES AND COVERS
CONDUIT FITTINGS FOR EVERY REQUIREMENT
FLOOR JUNCTION BOXES, INSULATOR SUPPORTS, CONDUIT BENDERS

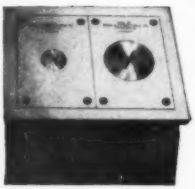
MR. PATTERSON
Still active as Board Chairman

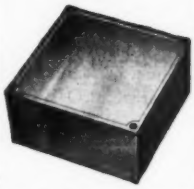
For *Almost* 50 Years

Steel City has been serving the electrical industry

Incorporated in 1904 by Mr. W. I. Patterson - who had been an electrical contractor since 1886 - and several associates, Steel City Electric Company has consistantly *Specialized* in designing and manufacturing Switch Boxes, Outlet Boxes and Covers, and Conduit Fittings that best serve the purpose for which they are intended and save installation time.

Due to this *Specialization* . . .



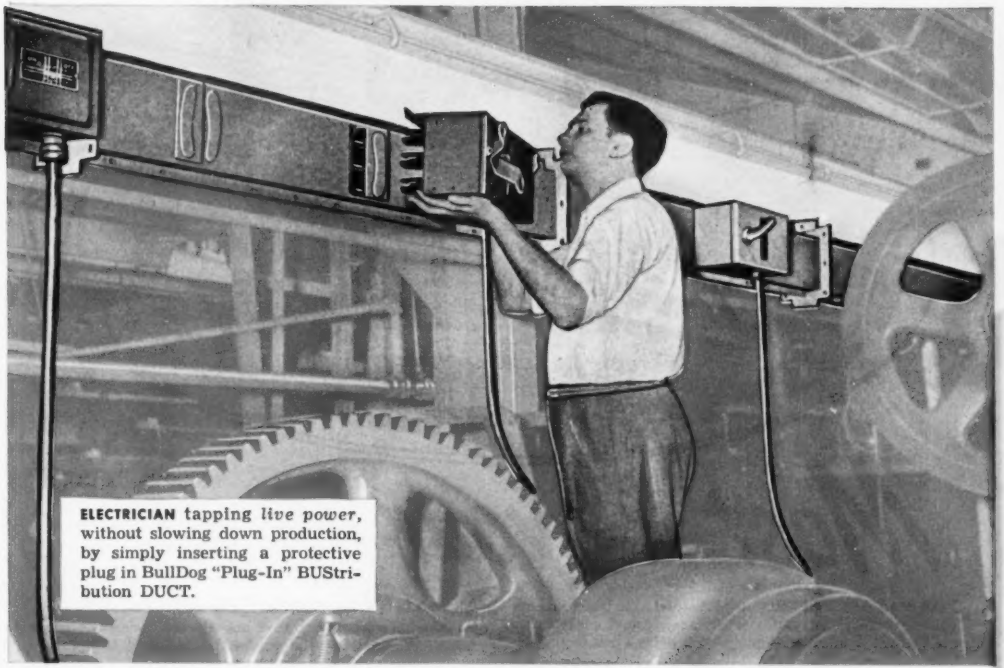


STEEL CITY LEADS IN MEETING CONTRACTORS' NEEDS

STEEL CITY ELECTRIC COMPANY

1207 COLUMBUS AVENUE, PITTSBURGH (33), PENNA.

Plug in "ON-THE-SPOT" POWER
. . . move machines anywhere, any time



ELECTRICIAN tapping *live power*, without slowing down production, by simply inserting a protective plug in BullDog "Plug-In" BUStribution DUCT.

Put extra profits in your production line with flexible BullDog BUStribution DUCT

HERE'S THE electrical distribution system that's right in step with your modern, expanding production facilities.

With BullDog "Plug-In" BUStribution DUCT, you can tap *live power* where you want it, when you want it. To move a machine, simply remove from the duct the plug that is feeding it electrical power. Move plug and machine to new location, and insert the plug in a convenient duct outlet.

It's as simple as that! Costly rewiring and expensive shutdowns of other machines are eliminated once and for all!

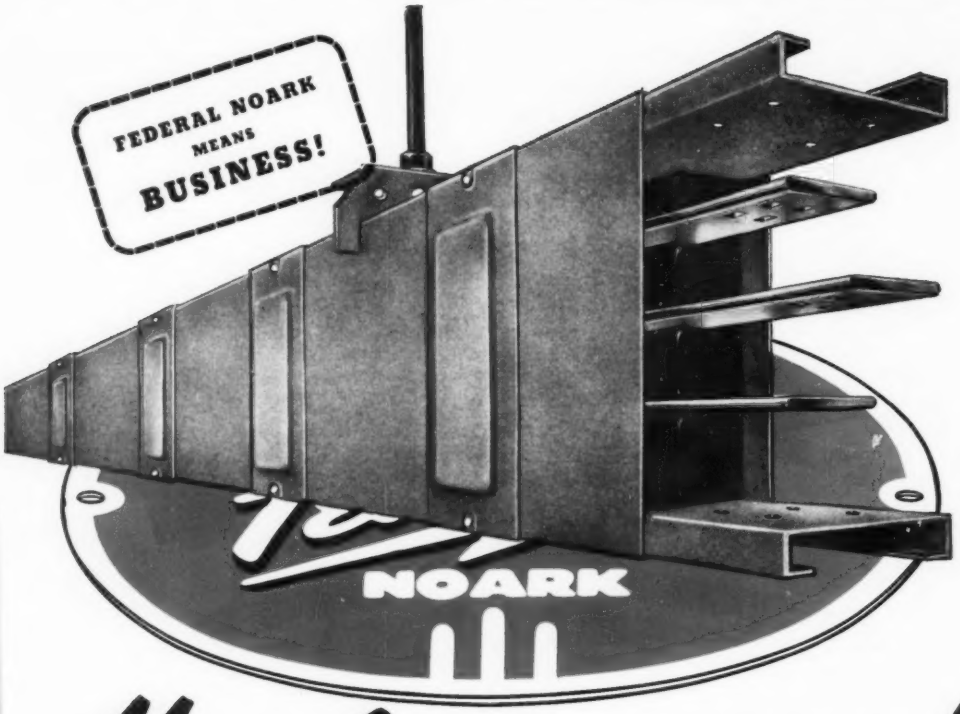
Your savings are threefold with flexible BullDog "Plug-In" BUStribution DUCT. Initial cost is low . . . practically no maintenance is required . . . safety and flexibility are at a maximum. Like all BullDog BUStribution systems, "Plug-In" DUCT is completely salvable . . . right down to the last nut and bolt.

Call your local BullDog Field Engineer soon for full information. He will be glad to show you an installation near your own plant.

BULLDOG ELECTRIC PRODUCTS COMPANY
DETROIT 32, MICHIGAN • FIELD OFFICES IN ALL PRINCIPAL CITIES
IN CANADA: BULLDOG ELECTRIC PRODUCTS OF CANADA, LTD., TORONTO

BULLDOG

PIONEERS IN FLEXIBLE ELECTRICAL DISTRIBUTION SYSTEMS



Most for your money!

FOR MAXIMUM SPEED of installation . . . topmost maintenance economy . . . operational ease, safety and efficiency . . . the Federal Noark Bus Duct system is today's best buy.

To begin with, the unique Noark adjustable sliding drop hanger permits the most convenient location of supporting rods and provides the quickest method for installing bus duct that was ever devised. And from then on you get all the advantages brought by Federal Noark Bus Duct special features:

Interlocking Four-Channel Steel Housing . . . welded and screwed together to assure greatest strength. Even the longest runs are bound to be straight and true.

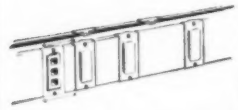
Extra Rugged Interior Construction . . . with the bus bars rigidly held by porcelain insulated receptacles every twelve inches. The bus bars are designed to withstand heavy fault currents.

Positive Contact . . . bus bars are silvered over their entire length. Plug-in stabs reinforced with heavy steel springs.

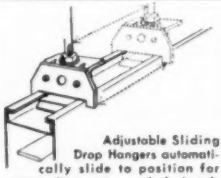
Insulated Plug-In Openings . . . no bus is exposed . . . operator is safe when changing plug-in device. For extra protection, new hook-on bars support plug-in device during installation.

Unsurpassed Heat Dissipation . . . staggering of insulators on alternate sides of duct provides continuous air passage and coolest operation.

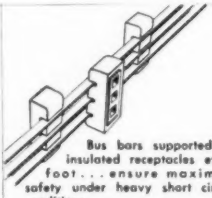
Federal Noark Bus Duct is factory-assembled in 10-foot sections, and completely flexible for future needs. For the full story, write Federal Electric Products Company, 50 Paris Street, Newark 5, New Jersey.



Sliding, self-locking cover plates, protecting insulated plug-in openings, safeguard electricians.



Adjustable Sliding Drop Hangers automatically slide to position for exact alignment . . . slash installation time.



Bus bars supported by insulated receptacles every foot . . . ensure maximum safety under heavy short circuit conditions.

Interlocking four-channel construction assures greatest strength . . . even long runs are straight as a plumb line.

FEDERAL NOARK

Complete line of Federal Electric Products includes Motor Controls, Safety Switches, Service Equipment, Circuit Breakers, Panelboards, Switchboards, Control Centers, Bus Duct ★ Sales offices in principal cities.

R&S LIGHTING FIXTURES

EXPLOSION-PROOF

CLASS I, GROUPS C & D

Wherever flammable materials are manufactured or used by industry, the complete line of R&S explosion-proof lighting fixtures is specified for the extra margin of safety and protection provided personnel and equipment in hazardous locations. There's an R&S fixture for every need . . . in pendant, ceiling, bracket or hand types . . . from 100 watt through 500 watt sizes. Standard conduit bases permit interchangeability of reflector globe assemblies.

WRITE FOR CATALOG NO. H-47

Ceiling Type with Guard — without Reflector

Pendant Type with Guard and Dome Reflector

Bracket Type with Guard — without Reflector

Pendant Type without Reflector

Wire Angle Reflector

With Standard Dome Reflector

Bracket Type without Reflector

VAPORTIGHT

The complete line of R&S Vaportight Lighting Fixtures offers maximum indoor and outdoor protection against non-inflammable gases, vapors, dusts and moisture. The fixtures are available in a wide range of ceiling, pendant and bracket types—in 15 watt through 500 watt sizes. Bases have wiring chambers that stay vaportight in service when globes are removed or broken. R&S outstanding vaportight qualities combined with superior illumination keep this fixture line out in front in fast-selling popularity and industry-wide acceptance.

WRITE FOR CATALOG NO. 9048-6

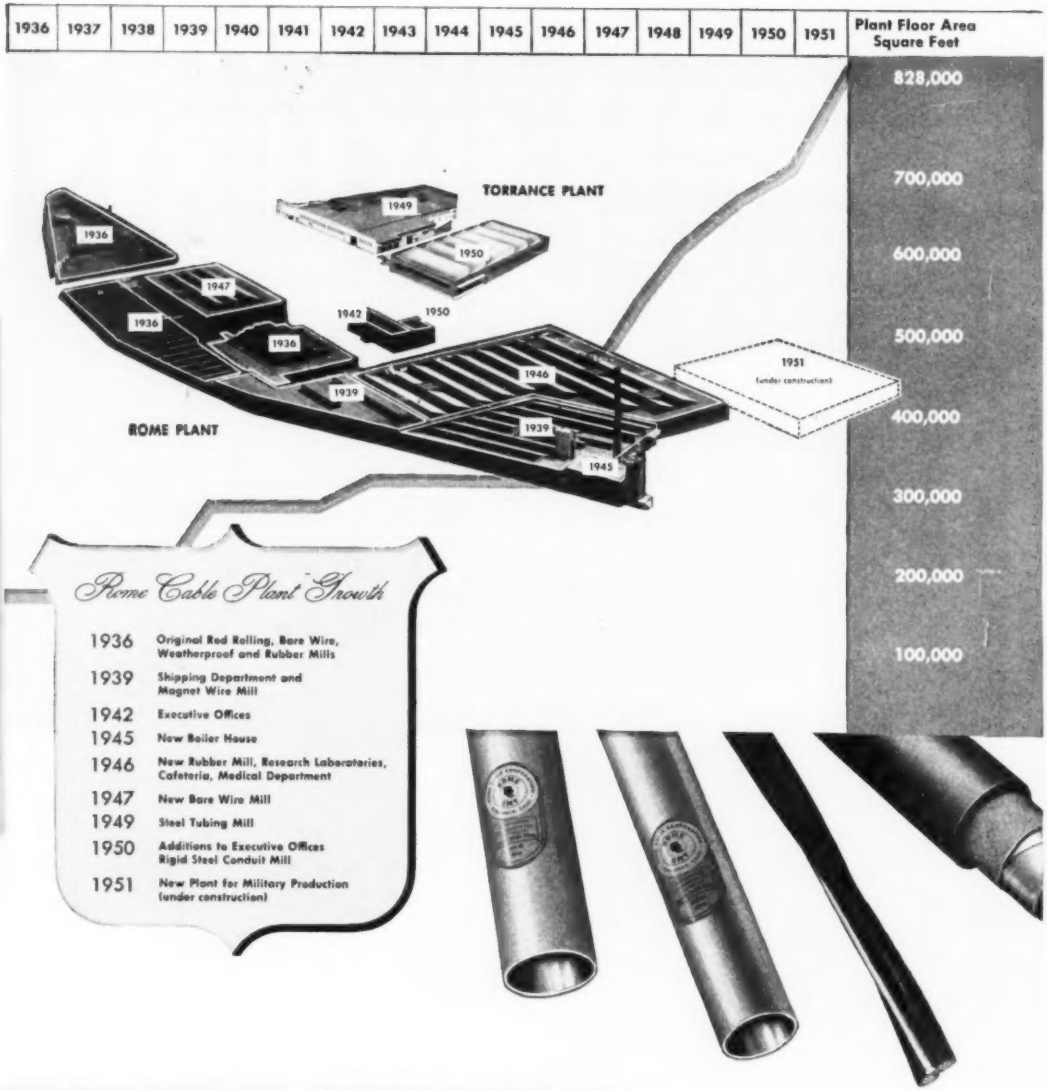
Sold through Electrical Wholesalers

RUSSELL & STOLL COMPANY, INC. • 125 BARCLAY STREET, NEW YORK 7, N. Y.

04

RUSSELL & STOLL

1936 - 1951



Rome Cable Plant Growth

1936	Original Rod Rolling, Bare Wire, Weatherproof and Rubber Mills
1939	Shipping Department and Magnet Wire Mill
1942	Executive Offices
1945	New Boiler House
1946	New Rubber Mill, Research Laboratories, Cafeteria, Medical Department
1947	New Bare Wire Mill
1949	Steel Tubing Mill
1950	Additions to Executive Offices Rigid Steel Conduit Mill
1951	New Plant for Military Production (under construction)

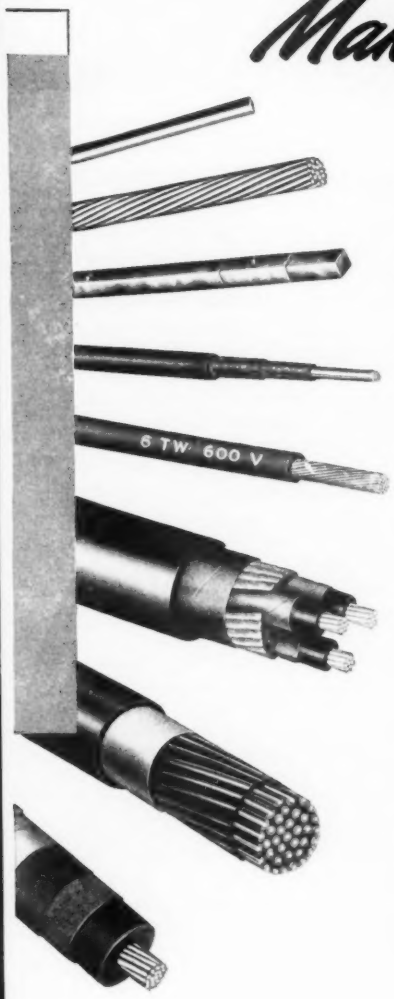
FROM BAR TO FINISHED WIRE... FROM SHEET TO FINISHED TUBE

In the manufacture of wires and cables, as well as steel conduit, control of Rome Cable quality is a step by step process. Starting with basic forms . . . copper wire bars and sheet steel . . . Rome Cable products are manufactured entirely within its own plants. Equipment of the latest design, capable research and engineering, plus rigid inspection assure you of uniformly high quality.

Rome Cable offers, also a *personalized service* . . . based upon intimate contact between buyer and seller. Strategically located sales offices and warehouses across the nation bring Rome Cable as close to you as your telephone. In this period of defense priority, material shortages are acute and delivery requirements cannot always be met. You can depend, however, upon Rome Cable doing its best and when it cannot, honestly saying so.

Write today for your complimentary copy of the attractively bound book, "The Story of Rome Cable Corporation," and learn more about Rome Cable's facilities.

. . . You've Helped Rome Cable Make The Years Count



Fifteen years ago this July, we made our first shipment of wires and cables to the electrical industry. Your ready acceptance of Rome Cable products since that time has more than justified our confidence in that first shipment.

Today, electrical power surges through Rome wires and cables of many types, in many places . . . powering vital industry, lighting cities, safeguarding life, bringing convenience and comfort to homes throughout the land.

Burrowing deep for vital minerals, carrying heavy power loads from city to city, turning the wheels of the nation's industry . . . Rome wires and cables are unfailingly at work.

When the farmer flips his barn switch for that 4 A.M. milking . . . when a hundred and one electrical conveniences are called into use . . . Rome wires and cables are at work.

When television gives you a ringside seat, when an electric mixer whips up a cool summer drink . . . or, a neon sign steers you toward a highway hamburger . . .Rome wires and cables are at work.

Yes, even when a telephone voice directs an artillery barrage into Korean hills . . . the vital thread of communication may well be a Rome product. For, today Rome Cable is, again, producing for defense.

So, for fifteen years Rome Cable has steadily grown in meeting your ever-increasing needs. Rome research and engineering have designed better cables, have maintained dependable, high quality . . . *to give you of the electrical industry only the best.*

At this milestone in our progress, we, again, dedicate our future to ever higher quality of product and the desire to serve *you who have made these years count.*

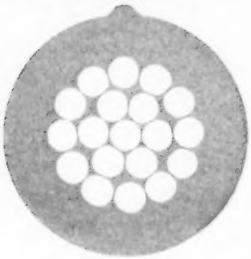
ELECTRICAL CONDUCTORS AND STEEL CONDUIT
OF *BETTER QUALITY*

It Costs Less To Buy the Best

ROME CABLE
Corporation
ROME • NEW YORK
and
TORRANCE • CALIFORNIA

ROME CABLE ROME, N.Y.

WHY OKONITE'S *STRIP INSULATING PROCESS*

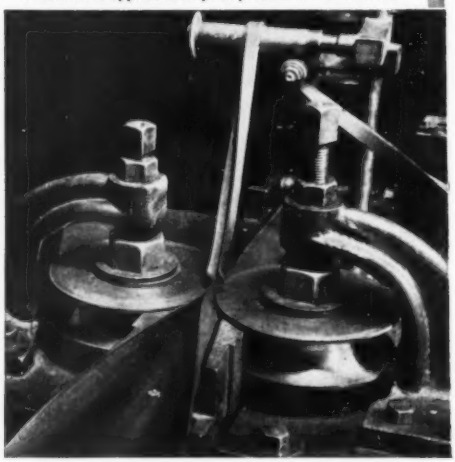


GIVES UNIFORM WALL THICKNESS— PERFECTLY CENTERED CONDUCTORS

Hit or miss centering of conductors within the insulating wall is eliminated by the strip process. In the first place, perfectly uniform wall thickness is assured because the thickness of the calendered strips is electro-magnetically measured before application. As a result, conductors are automatically perfectly centered.

Furthermore, since the insulation is encompassed in a continuous metal mold during vulcanization, swelling is prevented and a more dense insulation secured.

Insulation is applied in strips of predetermined thickness



Okonite is the only cable manufacturer using the strip insulating process as a standard procedure. Of all types of processing and applying rubber compound insulations, NONE can compare with the strip process for *assuring circuit security*.

Okonite is uniquely unbiased in making this statement, because *this company alone* is fully equipped to use all other available methods—i.e. extrusion, latex dip and continuous vulcanization. You can have your choice. Yet, year after year, the unparalleled performance of strip insulated cables strengthens the proof that no other insulating method even approaches the strip process. Its greatest tribute is that despite higher initial cost, engineers all over the world continue to demand it for cables that *must not fail*. And over the years, the trouble-free service obtained from Okonite strip-insulated cables more than repays the added cost.

The logical reasons for the superiority of the strip process are briefly explained on these pages. Compare its advantages and judge for yourself.

AVOIDS EXCESSIVE BREAKDOWN OF RUBBER

In order for rubber insulations to be applied by ordinary extrusion, the compound must be softened by prolonged "breaking down" of the rubber hydrocarbon. Thus treated, the material never again regains fully its natural characteristics; its original vitality has been deadened.

In Okonite's strip insulating process, the calendered strips, however, are applied in a much firmer and tougher form. The insulating compound does not have to be excessively broken down. Better physical, electrical and aging qualities result.

OKONITE

assures unequalled service– highest dielectric strength– in electrical cables

Every foot of insulation is inspected before application

PERMITS TESTING AND INSPECTING *BEFORE* APPLICATION

One of the greatest virtues of the strip process is that the calendered strips can be carefully inspected and electrically tested throughout their entire length *before* application to the conductor. Such a procedure is of course impossible in any other type of application.

ASSURES UNIFORM VULCANIZATION AND BOND

1. Use of the metal mold assures uniform vulcanization throughout the entire length of the cable.
2. Insulation and sheath are vulcanized together simultaneously to produce a permanent bond.
3. Avoids multiple vulcanization that shortens the life of rubber compounds.

Insulation is vulcanized under pressure in continuous metal mold

PROOF OF THE PIE

No other cable manufacturer gives such intensive, super-voltage a-c and d-c tests for your protection. With ordinary cables, the rate of production failure under such tests would be ruinous.

Okolite-Okoprene, however, is built from the conductor out with an extra margin of dielectric and mechanical strength. Research, premium materials, and rigid inspection controls are all of course important. But the use of the unique Okonite strip process probably contributes most importantly of all to the long life and reliability of the Okolite-Okoprene cable you buy.

For complete information on how the Okonite strip process assures stronger insulation, uniform walls, perfectly centered conductors, uniform vulcanization, and permits testing prior to application, write for Bulletin EC-1053 to The Okonite Company, Passaic, N. J.

Super-voltage proof tests are severest in entire industry

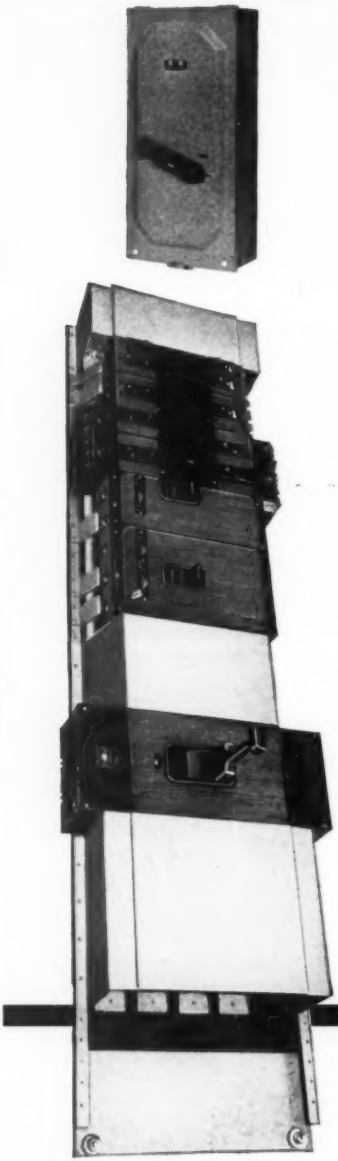
DO YOU KNOW that in Okolite-Okoprene cables the Okolite insulation and Okoprene sheath are applied in the same operation and vulcanized simultaneously in a metal mold?

THE BEST CABLE IS YOUR BEST POLICY

OKONITE SINCE 1878 ***insulated wires and cables***

To meet any Circuit Protection needs

CHOOSE FROM THE COMPLETE LINE OF



I-T-E breakers provide consistent, dependable overcurrent protection in

PANELBOARDS • SWITCHBOARDS
LOAD CENTERS • INDIVIDUAL ENCLOSURES

The full line of I-T-E molded case circuit breakers meets any need. The I-T-E line provides safe, dependable, overcurrent protection for all lighting, power and distribution circuits.

When you choose a circuit breaker made by I-T-E you get:

LONG LIFE—Rugged, dependable I-T-E construction assures maximum service.

EXTRA SAFETY—Completely enclosed terminals mean added protection. Greater pole center spacings afford extra electrical clearance.

EASE OF APPLICATION—Uniform design on multiple pole center dimensions provides ease in mounting and construction. Special devices are available compactly mounted within the breaker case.

I-T-E circuit breakers cover a full range of ratings:

Voltages 125—600 volts a-c
125—250 volts d-c

Continuous current 10—600 amperes

Interrupting capacity 5000—25,000 amperes

1, 2, or 3 poles

Approved by the Underwriters Laboratories, Inc.

For further information on circuit breakers to meet your needs, write I-T-E Circuit Breaker Company, 19th & Hamilton Streets, Philadelphia 30, Pennsylvania.

I-T-E CIRCUIT BREAKER COMPANY

Subsidiaries:

Railway and Industrial Engineering Co., Greensburg, Pa.
Eastern Power Devices, Ltd., Toronto, Canada

I-T-E MOLDED CASE CIRCUIT BREAKERS

SELECT THE RATINGS AND DEVICES TO FIT YOUR APPLICATION

	Ratings Protective and Other Devices Special Features		SQ 50 Amp Frame	ET 50 Amp Frame Ft. and Ind. Mtg	ET 100 Amp Frame "J"	ET 100 Amp Frame "G"	ET 225 Amp Frame "K"	ET 600 Amp Frame "L"
			1 and 2 Pole	1, 2 and 3 Pole	2 and 3 Pole	2 and 3 Pole	2 and 3 Pole	2 and 3 Pole
Ratings	Ampere Ratings		10-50 A	15-50 A	15-100 A	50-100 A	70-225 A	125-600 A
	A-C Voltage Ratings		1 P 120 V 2 P 120/240 V	1 P 125 V 2 and 3 P 250 V	LV 250 V HV 600 V	LV 250 V HV 600 V	LV 250 V HV 600 V	LV 250 V HV 600 V
	D-C Voltage Ratings		—	1 P 125 V 2 and 3 Pr 125, 250 V	LV 125/250 V HV 250 V	LV 125/250 V HV 250 V	125/250 V and 250 V	125/250 V and 250 V
	Interrupting Ratings	a-c	5,000 A	5,000 A	LV 5,000 A HV 10,000 A	—	10,000 A	10,000 A
	Underwriters' Labs. Inc.	d-c	—	5,000 A	5,000 A	—	10,000 A	10,000 A
	Interrupting Ratings	a-c	5,000 A	5,000 A	LV 5,000 A HV 15,000 A	15,000 A	15,000 A	25,000 A
	NEMA	d-c	—	5,000 A	LV 5,000 A HV 10,000 A	5,000 A 10,000 A	10,000 A	30,000 A
	Quick-Make Quick-Break Mechanism		✓	✓	✓	✓	✓	✓
Protective Devices	Thermal Trip	N	—	✓	—	—	—	—
		I	—	—	—	—	—	—
	Thermal Fixed Magnetic Trip	N	✓	—	✓	✓	—	—
		I	—	—	—	—	—	—
	Thermal Adjustable Magnetic Trip	N	—	—	—	—	—	—
		I	—	—	—	—	✓	✓
	Adjustable Magnetic Trip	N	—	—	✓*	—	—	—
		I	—	—	—	—	✓*	✓*
	Undervoltage Trip		—	—	✓	✓	✓	✓
Other Devices	Shunt Trip		—	—	✓	✓	✓	✓
	Auxiliary Switch		—	—	✓	✓	✓	✓
	Alarm Switch		—	—	✓	✓	✓	✓
	Mechanical Interlock		—	—	✓	✓	✓	✓
	Field Discharge Contact		—	—	✓	—	✓	✓
Other Features	Non-Automatic		—	✓	✓	✓	✓	✓
	Oil Immersed		—	—	✓*	—	✓*	✓*
	Center Studs		—	—	✓	✓	✓	✓
	Drawout Connectors		—	—	✓	—	✓	✓

* —Available in 250 V d-c, 600 a-c only.
N—Non-interchangeable overcurrent trip.
I —Interchangeable overcurrent trip.

WANT MORE INFORMATION?

Bulletin 5004-D gives description of the complete I-T-E line.

Catalog Section 5000 contains technical selection and application data, dimensions and prices. It's yours for the asking.

LEVITON

1915 — 1951

Pioneering with a pull chain socket in the 'teens of this century, LEVITON electrical wiring devices have set the pace in an electrical era that saw the carbon lamp develop into the streamlined lighting of today.

Keeping abreast of these ceaseless improvements in design and automatic techniques, LEVITON'S production facilities now comprise three large plants, equipped with the most modern machinery, to produce from critically selected raw materials, wiring devices and insulated wire and cable to meet the ever growing demand.

LEVITON, thru distributors the world over and strategically located warehouses, is uniquely able to offer, the right device, at the right time, in quantities needed, to meet the most rigid installation requirements.

AMERICAN
INSULATED
WIRE COMPANY
a subsidiary of
the Leviton Company

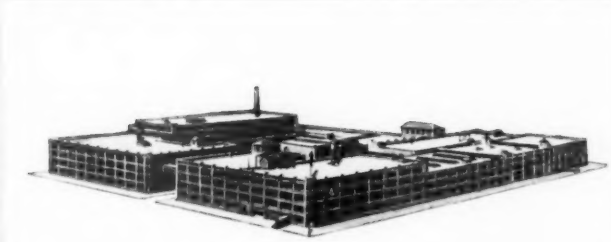
LEVITON MANUFACTURING COMPANY

Brooklyn 22, New York

WAREHOUSES: CHICAGO AND LOS ANGELES • OFFICES IN ALL PRINCIPAL CITIES

Pawtucket
Rhode Island
Plant

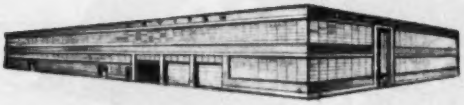
Hillsgrove
Rhode Island
Plant

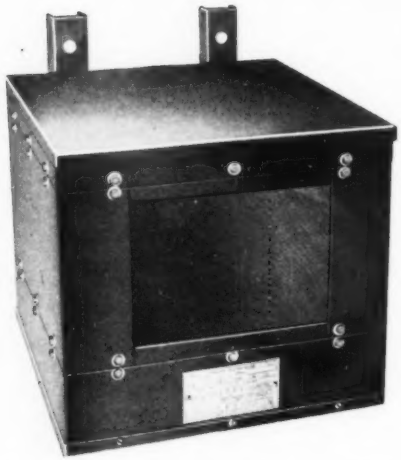


main plant: Brooklyn, New York

warehouse: Los Angeles

warehouse: Chicago





DONGAN POWER CIRCUIT TRANSFORMERS

•

The Most Economical Way of Providing Low Voltage Circuits

•

ESPECIALLY designed for use on circuits of 600 volts or less. Sizes: 50 V.A. to 37½ K.V.A. Primary and secondary are in separate compartments, eliminating the necessity of additional wiring boxes.

WRITE FOR NEW CATALOG

DONGAN ELECTRIC MFG. CO.
2980 Franklin Detroit 7, Mich.

The Dongan Line Since Nineteen-Nine

DONGAN TRANSFORMERS

All the outlets you need for efficient use of portable power tools . . .

Pierceway
PLASTIC DUCT
WIRING SYSTEMS

Pierceway systems provide an outlet approximately every 8 inches—and adequate power for all requirements. 60-ampere copper conductors are built in each section of the shock-proof plastic duct. Pierceway systems are easy to assemble and install, and can be quickly dismantled and reassembled at any time circuit changes are required. All parts are 100% salvable.

Pierceway can be assembled into any type of 2-wire or 3-wire circuits, in systems of any size. Available in separate grounded systems and with Pierceway Twist-Lock receptacles.

PACKAGED BENCH INSTALLATIONS

Pierceway systems for installation on work benches are available in packaged form, ready to assemble and install. Three lengths (6 to 14 outlets), end-feed or back-feed type.

PIERCEWAY DIVISION
Clifton Conduit Company, Inc.
1278 Orgill Avenue, Memphis 6, Tenn.

Killark

KILLARK ST. LOUIS

PARTNER IN HALF A CENTURY OF ELECTRICAL PROGRESS

PIONEER IN MODERN ALUMINUM FITTINGS

Already tested and thoroughly approved in the field, Killark fittings are the first major improvement in fittings in over fifty years. The result of over seven years intensive metallurgical research and design engineering, Killark fittings are made of new Alumalloy . . . to provide a new combination of high strength, lightness, safety and uniformity. Corrosion- and weather-proof clear through, Killark fittings are good for a lifetime of service in acid, salt, or chemical atmospheres. And actual weather tests, over a ten-year period, have proved that Killark Alumalloy fittings are superior to other metals.

"LOOK AHEAD . . . LOOK TO KILLARK"

IMMEDIATE DELIVERIES ON ALMOST ALL ITEMS

KILLARK ST. LOUIS

Killark

ELECTRIC MANUFACTURING COMPANY

Vandeventer and Easton Aves. St. Louis 13, Missouri

SALES OFFICES and WAREHOUSE STOCKS	BOSTON	156 Purchase St.	PITTSBURGH	50 26th Street	SAN FRANCISCO	140 Spear St.
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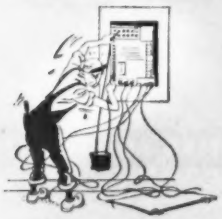
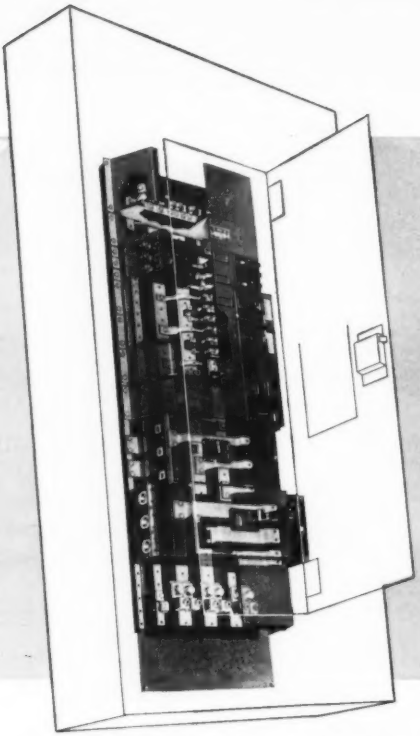
	ATLANTA	69 Mills Street, N. W.	SEATTLE	4130 First Avenue South	DALLAS	1901 Griffin Street
SALES OFFICES	COLUMBUS	2620 Welsford Road	MINNEAPOLIS	924 Andrus Bldg.	NEW YORK	30 Irving Place
	CINCINNATI	49 Central Avenue	KANSAS CITY, MO.	614 West 26th Street	BALTIMORE	401 Natl. Marine Bank Bldg.

PRE-TAPPED BUS BARS AND BACK PAN FOR QUICK CHANGE-OVER



PHASE IDENTIFICATION ON LIGHTING BOARDS ELIMINATES RING-OUT TIME



NEUTRAL BAR EXTENSIONS ON LARGE DISTRIBUTION PANELBOARDS ELIMINATE CABLE WASTE

INDICATING TRIM CLAMPS SPEED CABINET INSTALLATION

Take an *EXTRA LOOK!*

for cost-saving extras provided by Westinghouse Panelboards

Fast installations cut panelboard costs. Fast conversions for changing or expanding power requirements cut costs. Recently a prominent trade publication stated that design—type and accessibility of connections, gutter and wiring space and other features—can influence panelboard installation time by as much as 25%.

Here are time-saving, cost-saving extras Westinghouse Panelboards give you:

1. Built-in Neutral Bar Extension on convertible distribution panelboards—eliminates dragging main feeders entire length of panelboard to reach neutral bar; now—locate all feeder terminal connections at same end of panel.
2. Pre-Tapped Bus Bars, back pan and other parts provide screw driver convertibility when needed.
3. Indicating Trim Clamps make it easy to get the trim on or off—eliminate guesswork.
4. Permanent Pre-phased Identification—letters at each breaker and main bus identify sequence of breaker and bus connections on 3-phase, 4-wire lighting panelboards.

Quick-fasten access plates, trim angle support, reinforced back pan, interchangeable parts are other advantages—extras at no extra cost—provided in Westinghouse Panelboards.

Contact your Westinghouse office or distributor. Or write for Descriptive Bulletin No. 30-930—Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-93466

YOU CAN BE SURE... IF IT'S

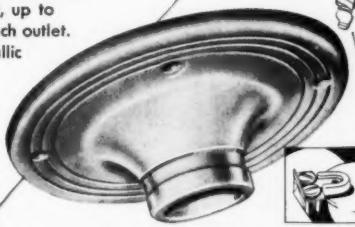
Westinghouse

PANELBOARDS

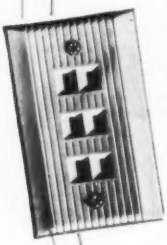
NEW IDEAS in specification grade devices

to save you time on wiring jobs!

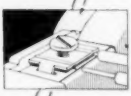
MONOWATT SURF-A-LINE WITH UREA BASES
Arc-resisting urea bases and high insulation barriers between current-carrying parts make these surface wiring devices better than ever . . . even under most severe conditions. Because Surf-A-Line combines box, device and cover into one unit, up to 50% installation time is saved at each outlet. For use with building wire, non-metallic and armored cable.



MONOWATT COMBINATION DEVICES — are pre-assembled as complete units. Easier, faster to wire . . . cost less than separate devices of equal quality. Just two screws mount complete unit. Flush mounting is automatic . . . no adjustments needed. Modern triple outlet (illus.) gives extra convenience of added outlet. Other combinations of outlets, single pole switches, 3-way switches, pilot lights available.



MONOWATT CEILING LAMPHOLDER — designed for speed in wiring, plus dependability. No internal mechanism to insert, no porcelain ring to work loose or crack. Double terminal screws for continuous wiring . . . eliminate soldering and taping. Units fit both 3¼" and 4" outlet boxes.



MONOWATT BREAK-OFF WALL PLATES — keep jobs moving. Plates can be used alone or ganged on the job to any combination. No stoppages for a special plate for a special purpose. Screws held in place with fiber washers for quick mounting.

Write today for catalog

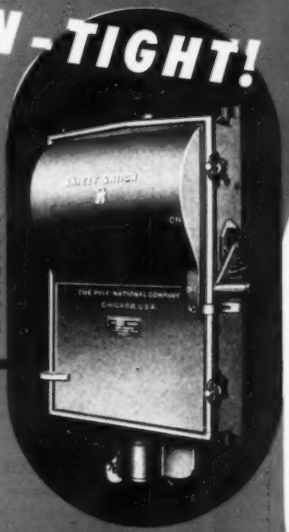
MONOWATT BACK-WIRED OUTLET. New wire clamp on this sturdily built double outlet simplifies wiring . . . eliminates working with binding screws in cramped space. Just strip about ⅜ inches of insulation off the conductor ends, slip them under the wire clamp and screw clamp down. Looping and twisting conductors around binding screws is eliminated, saving time and wire at each outlet.

MONOWATT

A DEPARTMENT OF GENERAL ELECTRIC COMPANY, PROVIDENCE 7, R. I.

Heavy Duty Safety Switch, and Circuit Breaker

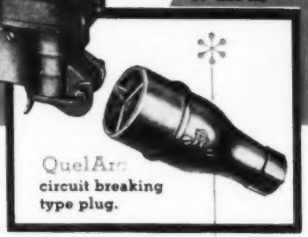
RAIN-TIGHT! DUST-TIGHT!



RAIN-TIGHT SAFETY SWITCHES with receptacle, fusible or fuseless, ratings up to 100 amps. 600 volts . . . without receptacle, up to 200 amps. 600 volts. (NEMA TYPES V, IV and III)

DUST-TIGHT AND RAIN-TIGHT CIRCUIT BREAKERS with receptacle, ratings up to 100 amps. 600 volts . . . without receptacle, up to 225 amps. 600 volts. Dust-tight types for hazardous locations, Class II, group E, F, and G. (NEMA TYPES IV, V, IV and III)

PYLETS



QuelArc circuit breaking type plug.

Designed for Safe, Reliable Operation and Protection of Portable and Stationary Electrical Equipment, indoors and outdoors, under the most severe operating conditions

MUCH LONGER SERVICE LIFE AND LOWER MAINTENANCE COSTS insured by heavy, rust-resisting cast metal construction and rain-tight gasket seals.

COMPLETE SAFETY FOR THE OPERATOR is provided by safety circuit grounding and the interlocking of door and plug receptacle with a quick make and break switch mechanism.

PYLE QuelArc plugs, used with this equipment, are well known industrially, for their unique partitioned construction. Long insulating surfaces from pole to pole, and from poles to ground provide for exceptionally safe handling and long service life.

Consult your Pylet Catalog, Bulletin 1150 for complete listings.

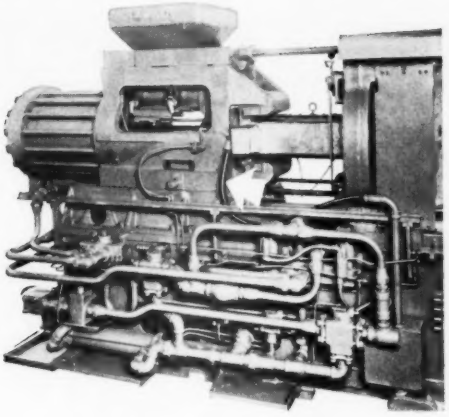
SINCE 1897

THE PYLE-NATIONAL COMPANY

1344 NORTH KOSTNER AVENUE, CHICAGO 51, ILLINOIS

District Offices and Representatives in Principal Cities of the United States
Export Department: International Railways Supply Co., 30 Church St., New York.
Canadian Agent: The Holden Co., Ltd., Montreal.

PLUGS AND RECEPTACLES • FLOODLIGHTS • TURBO-GENERATORS • GYRALITES • CONDUIT FITTINGS • MULTI-VENT AIR DISTRIBUTION



In this Model 10 H-32 oz. Reed-Prentice plastic injection molding machine, Sealtite protects the heating chamber control wiring.

THE Reed-Prentice Corp., world's largest makers of plastic injection molding machines, solves numerous wiring-protection problems on its equipment with flexible Sealtite* Electrical Conduit.

Where connections are cramped or bends are short, Sealtite is far easier to install. Where movement is called for, Sealtite permits it; where vibration exists, Sealtite absorbs it. Sealtite's liquid-tight, synthetic jacket resists oils, most chemicals, and gases. Its tough steel core stands up under impact.

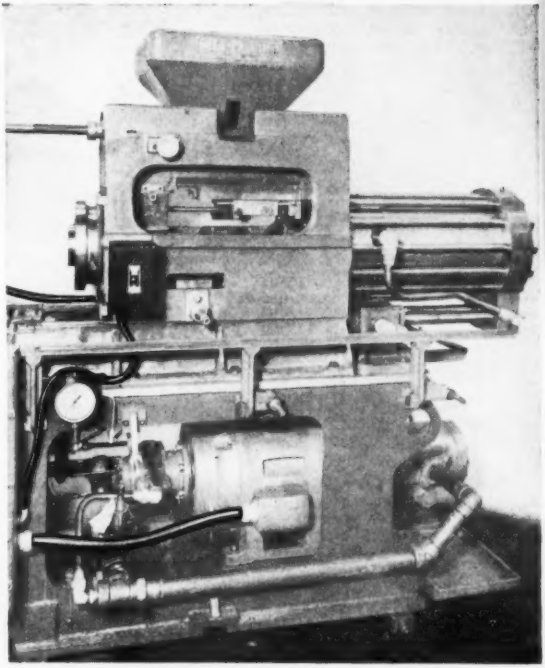
Sealtite's adaptability on machines like these is only one example of its usefulness. It's equally versatile in chemical plants, food processing industries, for making cramped conduit installations anywhere . . . for permanent or temporary wiring installations. Your electrical supply house carries Sealtite—and will be glad to tell you more about it. The American Brass Company, American Metal Hose Branch, Waterbury 20, Connecticut. In Canada: The Canadian Fairbanks-Morse Company, Ltd. A1256

*Trademark

Let SEALTITE **flexible and liquid-tight** conduit

simplify your wiring

Reed-Prentice Model 10 E-16 oz. plastic injection molding machine showing plunger end. The horizontal Sealtite Conduit carries wiring to 30-hp motor. The vertical Sealtite Conduit carries control leads to synchronous timer.



for **flexible, liquid-tight**
electrical conduit . . .
specify SEALTITE

AN ANACONDA® PRODUCT

FULLMAN **Latrobe** PRODUCTS

FLOOR BOXES ★ WIRING SPECIALTIES

FULLMAN MANUFACTURING CO. QUALITY LATROBE SUPREMACY LATROBE, PA.

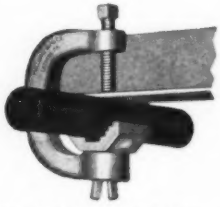
TOP PERFORMERS

"Latrobe" Floor Boxes and Wiring Specialties are top performers because they are expertly designed of the finest materials.

"Latrobe" Products are proof that the shortest road to efficiency and economy lies through quality.

No. 252-R Two Gang Box

This Two Gang Adjustable Box has minimum of parts with maximum of efficiency. ½" Flush Brass Plug with one Cover Plate; 2" Flush Brass Plug with other.



No. 470 "Bull Dog" Pipe or Conduit Hanger

This sure grip Bull Dog hanger is economical and dependable. Hangs pipe or conduit ½", ¾" and 1" to steel beams ⅜" thick.

No. 150 Box—No. 207 Nozzle

An adjustable, watertight box for dependable service in concrete or wood-finished concrete floors. 4¼" Cover Plate No. 242 and large Adjusting Ring No. 215.

No. 110 "Latrobe" Watertight Box

The No. 110 "Latrobe" Box is extremely simple and compact in design, making for speedy installation and smooth service. Has 208 Receptacle and Cover Plate 3½" diam.

Sold Only Through Wholesalers

"Bull Dog" BX Cable Staples

Favorites in every section of the United States, "Bull Dog" high quality staples can be ordered in cartons, kegs or barrels; 2500, 6000, 30000.

"Bull Dog" Insulator Supports

Famous "Bull Dog" Supports can be completely trusted for fastening porcelain or glass insulators to exposed steel framework. Four sizes, from 1" to 2½".

FULLMAN MANUFACTURING CO.
LATROBE . . . PENNSYLVANIA

SPECIFY THE BEST

INSIST ON

INTER-MATIC

TIME SWITCHES

for all automatic control requirements—*accept no substitutes!*

- 35 amperes at 125 volts.
- Mechanism removed merely by pressing spring clasp.
- Easy-to-set time dial . . . turns in either direction.
- Front-mounted motor . . . check operation thru window in cover.
- No special dial required when adding trippers.
- Trippers added easily without removing dial.
- From 1 to 12 "on" and "off" operations every 24 hours.
- Combination ½" and ¾" knockouts in back, bottom, and sides.
- Convenient mounting holes for quick installation.
- Light gray drawn steel case . . . 7¾" high, 5" wide, 3" deep.
- Fully guaranteed . . . U. L. approved.

Write TODAY for FREE Catalog.

INTERNATIONAL REGISTER CO.
2624 W. Washington Blvd.
Dept. 71-B,
Chicago 12, Ill.

only **$10.95** and up LIST f.o.b. factory Chicago

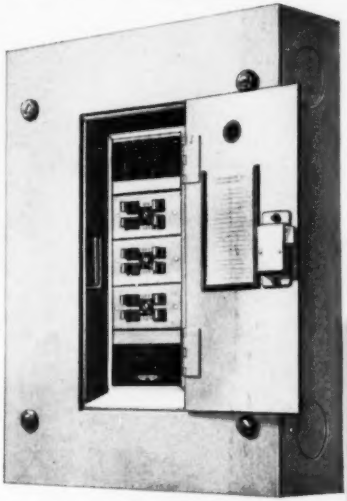
Makers of precision products for over 60 years!

INTER-MATIC TIME SWITCH

PICK 'EM OUT
PLUG 'EM IN

1 Select Multi-Breaker units required by job.

2 Assemble units to panel by "plugging in".



Make up the Cutler-Hammer Type NMO
MULTI-BREAKER "Plug-In"
BREAKERPANELS
TRADE MARK

on the job - for the job

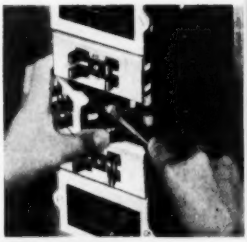
No matter what the job calls for when you get there, you are all set when you have a Cutler-Hammer Type NMO Breakerpanel. No matter what circuit load changes may be required if you are called back later on, you are *ready* if you have installed a Cutler-Hammer Type NMO Breakerpanel. For you make up these distribution centers with the Multi-Breaker Plug-Ins right on the job for the job. No guesswork. No mistakes. The Multi-Breaker units you select to serve your circuits just plug into place. Where you want a 15 ampere breaker, you plug in a unit containing the exact number of 15 ampere single pole breakers required up to four. These units are available in 29 different circuit combinations making it possible to obtain the exact quantity and rating of branch circuits with a minimum of effort.

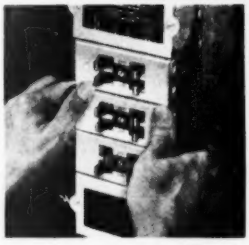
Cutler-Hammer Type NMO "Plug-In" Breakerpanels are now offered in sizes with from 8 to 42 single pole branch circuits in increments of 2. They are available in 120/240 Volts a.c., with 50, 100 and 200 ampere mains (lugs or circuit breaker) with 15, 20 and 30 ampere single and double-pole branch circuits; also, 40 and 50 ampere double-pole branch circuits. Multi-Breaker units are of the thermal-magnetic type that provide a lag on harmless overloads but instant trip on shorts.

Wiring these Type NMO Multi-Breaker units is also a cinch. You can wire them right in your hands before you plug them in . . . or you can simply swing them out for wiring as shown, using one of the positive-pressure contact jaws turning on the silvered bus bar as a hinge. And despite the small size of these Breakerpanels that better utilize wall and column space, you get much more gutter space (5½" in the 15" box) *with* more circuits. The narrow column type actually has *double* the number of circuits previously available in cabinets of similar height.

Beyond any doubt, this is the finest protection, the easiest to install, the most flexible, the most compact, and the most modern it is possible to obtain where a large number of branch circuits must be served, as in commercial and industrial buildings, hotels, schools, hospitals, large homes, etc. CUTLER-HAMMER, Inc., 1306 St. Paul Avenue, Milwaukee 1, Wisconsin.

3 Wire them.

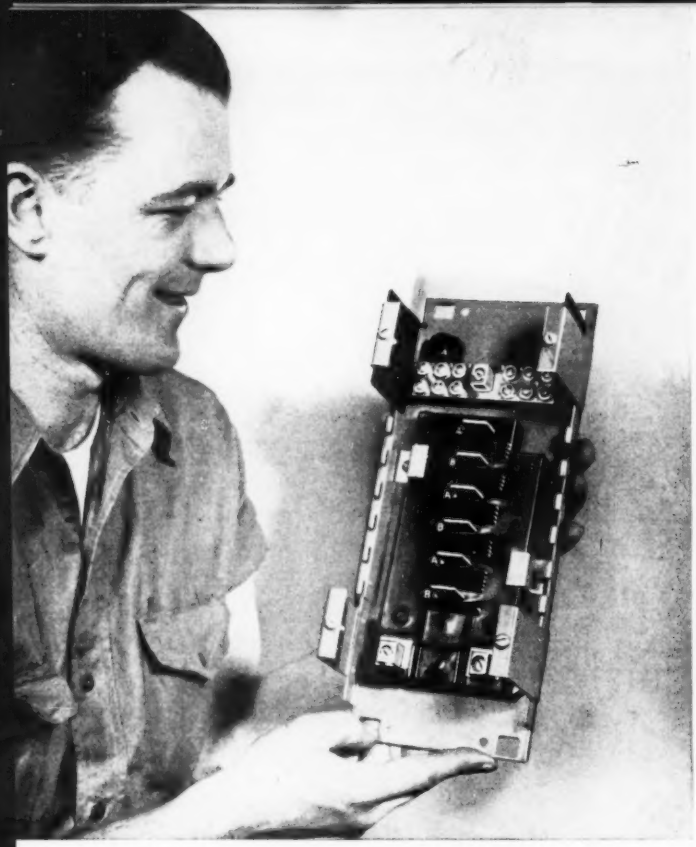


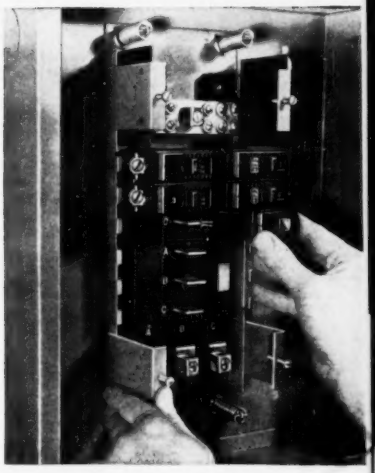


4 Plug them in place again.

CUTLER-HAMMER
BREAKERPANELS
C-H

KWIKON
KWIKON
KWIKON





ANOTHER TALKING POINT IS THE BREAKER—Trumbull's new NLTQ Panelboard introduces the first *plug-in* circuit breaker with quick-make, quick-break operation. Other features: both *thermal* and *magnetic* protection . . . trip-free . . . pressure-type, silver-plated copper plug-in contacts . . . all ratings physically interchangeable. Adjacent breakers are on alternate phases—assuring balanced loads and circuits.

New insulating material

MAKES PANELBOARD SALES!

The base of this panelboard interior is made of *Plastisol* . . . the first time this amazing plastic material has been used for this purpose.

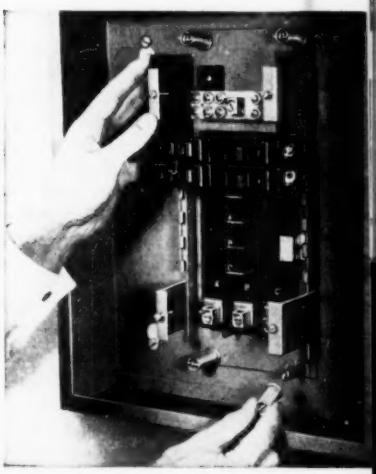
Here are some reasons for your recommending Trumbull's new NLTQ Panelboard to your customers.

Plastisol has very high thermal conductivity and is an excellent radiator of heat. Copper bus bars encased in Plastisol run 10% cooler than in open air!

SALES POINTS THAT OUT-SELL OTHER INSULATION

Other Plastisol advantages making it superior to all other types of insulation for this purpose include its ability to resist acid and alkali, high temperatures (not harmed at 212 F), tracking and carbonizing. It will not shrink or become brittle, even at minus 30 F.

Trumbull's Plastisol base is Underwriters' Laboratories, Inc. approved and endorsed by the Electrical Council.



YOUR CUSTOMERS WILL LIKE QUICK INSTALLATION—Interior is mounted in box by compression springs . . . which permit easy release for removal. Springs also permit lining up fronts regardless of uneven box installation. Trumbull NLTQ panelboards with lug or circuit breaker mains come in capacities up to 225 amperes in a range of 4 to 42 circuits. Write for Bulletin TEB-14.

TRUMBULL (T) ELECTRIC

DEPARTMENT OF GENERAL ELECTRIC COMPANY
PLAINVILLE, CONN.

P&S® PIONEERING since 1890

THIS AD APPEARED IN NATIONAL ELECTRICAL CONTRACTOR IN 1901

. . . And Still at It!

There's no substitute for experience—and Pass and Seymour have pioneered in the manufacture of newer and better wiring devices since 1890—originated such developments as—

- Screw Ring Lampholders
- Porcelain Sign Receptacles
- Shurlok Locking Lampholders
- Porcelain Box Mounting Lampholders
- Alabax Lighting Fixtures
- P&S-Despard Interchangeable Devices
- New Process Metal Plates
- P&S Surfex for Surface Wiring
- Uniline Design Plastic Wall Plates

Constantly designing new products and improving old, to give you the most modern, efficient wiring devices on the market—during the past few months P&S have introduced—an entirely new line of box cover switches—a new Neon pilot light and time-saving Camstrap for the P&S-Despard Line—a new range outlet with "lay-in" terminals—a redesigned line of polarized devices—new All-Plastic Surfex—a new easy-to-wire duplex outlet.

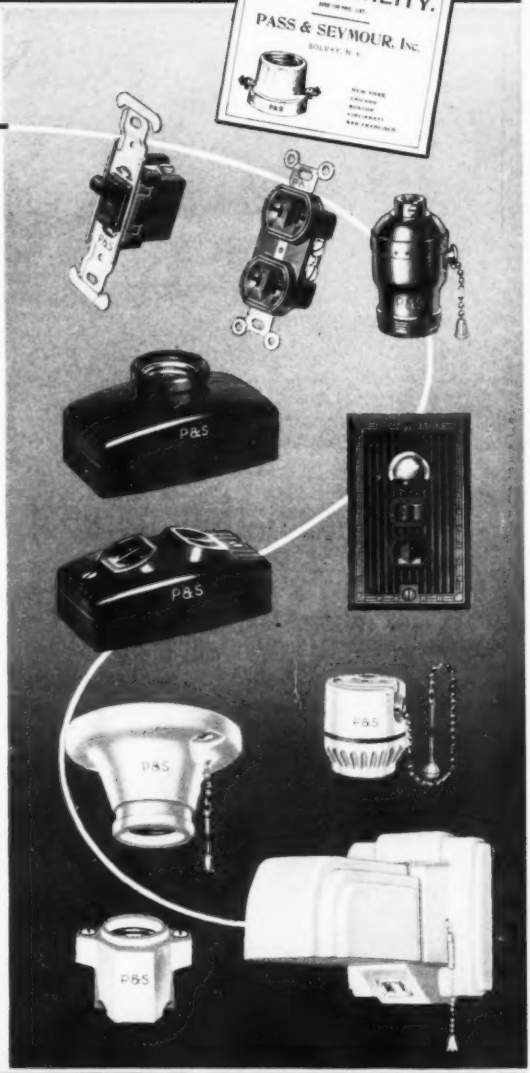
If you do not have information on these new P&S devices, write us today.

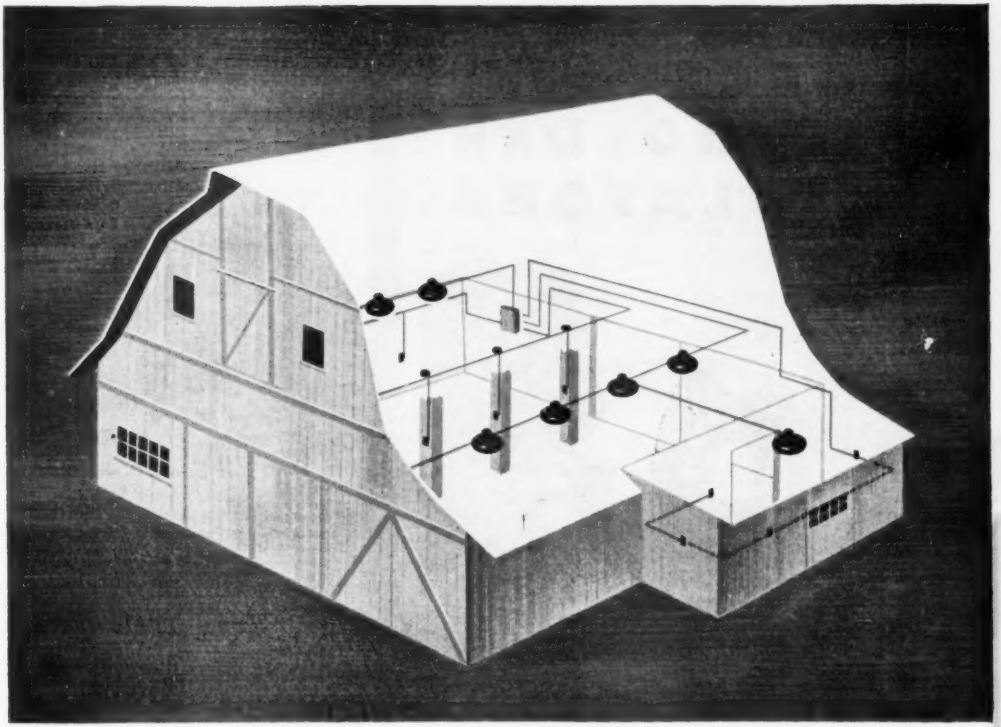
Specify P&S by catalog number and be sure of the best.

PASS & SEYMOUR, INC.

DEPT. M

SYRACUSE 9, NEW YORK





PLAN FOR PERMANENCE...

when you install rubber-covered barn cable

Next time you contract for a farm wiring job, you'll build customer good will if you install long-lasting rubber-covered barn cable made with Fiberglas* Yarns.

Fiberglas Yarns:

- ***will not rot!***
- **will not absorb moisture!**
- **resist chemicals and acids!**
- **have great tensile strength!**
- **help make barn cable *last far longer!***

OWENS-CORNING
FIBERGLAS
Yarns

*Fiberglas is the trade-mark (Reg. U. S. Pat. Off.) of Owens-Corning Fiberglas Corporation for a variety of products made of or with fibrous glass.

Because of increasing military requirements for Fiberglas Yarns, our customers are unable to get all they need. We are building new facilities to help meet these demands.

OWENS-CORNING FIBERGLAS CORPORATION
Electrical Sales Division, Dept. 856
16 E. 56th Street, New York 22, N. Y.

Please send me a copy of the new booklet describing wires and cables made with Fiberglas Yarns.

NAME_____

TITLE_____

COMPANY_____

STREET_____

CITY_____ ZONE____ STATE_____

FIBERGLAS IS IN YOUR LIFE...FOR GOOD!

PORCELAIN WIREHOLDER INSULATORS

MADE RIGHT BY ILLINOIS

Illinois dry process wireholder insulators are uniformly made to meet exact specifications in sufficient styles and sizes for all requirements. Smooth, rounded surfaces protect wire insulation—deep, sharp screw threads assure easy and firm installation. Non-shrinking metal alloy binds screws permanently to insulators. Steel screws are evenly coated by special galvanizing process to prevent rust streaks on sides of buildings. Wet process porcelain supplied for primary circuits.

- *HIGH MECHANICAL STRENGTH*
- *HIGH DIELECTRIC STRENGTH*
- *EXACT DIMENSIONS AND UNIFORMITY*

®

ILLINOIS
ELECTRIC PORCELAIN CO.

•
MACOMB, ILLINOIS

HI TRADE MARK

. . . Electrical and mechanical products answer the call of progress . . .

Plastic expanding Screw Anchor Universal—all-purpose

Tremendous holding power. Surprisingly low in cost. Millions in use. Delivered from stock. Underwriters' Laboratories approved.

Special Introductory offer. No. 3 Anchor and Drill Kit Anchors in Cartons.

$15.00 value for only $10.00

Users prefer "HI" Connectors Approved by leading Electrical Authorities

Millions in use—here's why

1. Cat. No's. Hi-4 and Hi-6 U.L. approved as pressure cable connectors for general use, such as raceway wiring.
2. Fully engineered — assure "tops" in wire joints.
3. Broad UL approval—serve a wider range of wire Combinations.
4. Inserts firmly lock onto wires—no more loose connections.
5. No loose springs—each is locked firmly in the shell.
6. Streamlined design—fit into shallow boxes.
7. Every "Hi" Connector shows the UL seal of approval.

"3 to 1" Fish Tape Reel and Puller

Offset seam-no sharp edges—permanent "black magic" finish — over zinc plating. Rust proof — No chipping. Highest grade fish tape-great tensile strength-controlled tension-perfect grip. Priced as low as $3.60 each.

"Easy-Strip" Wire Strippers

There are 2 models and 10 catalog numbers for wire sizes 8—30 solid or stranded, parallel wire such as No. 18 WSI and 300 ohm flat twin lead in. Designed to fit the hand and are a balanced stripper. Forged steel handles. Hardened steel blades and jaws. Adjustable stop free with each tool. Tap new thumb trigger with thumb, and jaws close instantly. Price each $4.95.

HOLUB industries inc.
SYCAMORE ILLINOIS

HI

V.C. CABLE

Wherever you need resistance to heat, oil and grease . . . specify Roebling Varnished Cambric

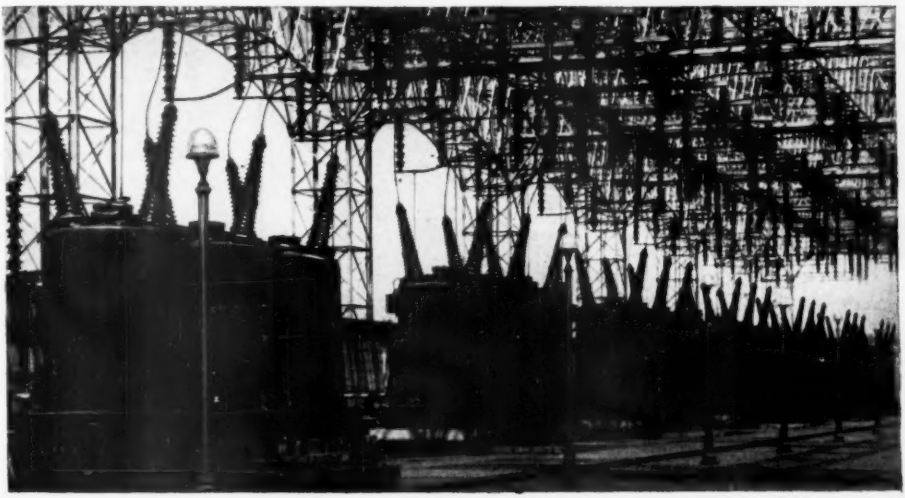
AS LEADS for generators, transformers, motor and oil switches . . . for general distribution of heavy power loads in manufacturing and industrial plants, your top specification is Roebling Varnished Cambric Cable. . . . Roebling V.C. is made in single conductor sizes from 2,000,000 C.M. to #14 A.W.G.; in multiple conductor sizes from 750,000 C.M. to #14 A.W.G. It is recommended for use up to 17,000v between phases in single or multiple conductor construction; and to 26,000v for single conductor grounded neutral.

Large quantities of Roebling's complete wire and cable line are now required in the rearmament program. The Roebling organization and distributors will do their best, however, to meet your delivery needs. John A. Roebling's Sons Company, Trenton 2, N. J.

Manufactured with solid conductors or stranded in a variety of strandings, coated or uncoated, according to your needs. Available in single or multiple conductor.

Insulated with varnished cambric tape, in accordance with I.P.C.E.A. and Underwriters' specifications unless otherwise specified by you.

For outside covering you have a choice of braid, for service in dry locations; lead, for service in damp locations; and for aerial use or direct burial we recommend a protective armor such as steel tape or galvanized round wire armor.



ROEBLING

Atlanta, 934 Avon Ave ★ ***Boston,*** 51 Sleeper St ★ ***Chicago,*** 5525 W. Roosevelt Rd ★ ***Cincinnati,*** 3253 Fredonia Ave ★ ***Cleveland,*** 701 St. Clair Ave, N.E. ★ ***Denver,*** 4801 Jackson St ★ ***Detroit,*** 915 Fisher Building ★ ***Houston,*** 6216 Navigation Blvd ★ ***Los Angeles,*** 216 S. Alameda St ★ ***New York,*** 19 Rector St ★ ***Odessa, Texas,*** 1920 E. 2nd St ★ ***Philadelphia,*** 230 Vine St ★ ***San Francisco,*** 1740 17th St ★ ***Seattle,*** 900 1st Ave, S. ★ ***Tulsa,*** 321 N. Cheyenne St ★ Export Sales Office, ***Trenton, N. J.***

JEFFERSON
Power Circuit
TRANSFORMERS

• Designed with the user in mind, Jefferson Power Circuit Transformers are generously proportioned to facilitate installation and simplify splicing of connections. Wiring compartments, large and roomy, are also equipped with handy ½" and ¾" knockouts for BX or conduit. Sturdy wall mounting brackets are an added convenience.

When you use Jefferson Transformers to step down the higher voltage main circuits, your savings are many. First, all power is brought through one entry and one meter; in addition, savings in copper, conduit, and fittings are appreciable.

Jefferson Transformers for power circuit duty are the dry type. They require no special vaults or cabinets. Mounting is made on post, walls, or directly on machine tools. Capacities range from 50 V. A. to 15000 V. A. (460/230V.—.30/115V. and 575V.—230/115V.)

Approved by Underwriters' Laboratories, Inc.

Sold Through Electrical Wholesalers
Write for illustrated Bulletin 501-15.

JEFFERSON ELECTRIC COMPANY

Bellwood, Illinois

In Canada: *Canadian Jefferson Electric Co., Ltd., 384 Pape Ave., Toronto, Ont*

DID YOU KNOW THAT...

In 1950 Electrical Construction and Maintenance published 13 articles on estimating? Basic stuff this estimating, very often it draws the line between profit and loss. By popular request last year's articles will be consolidated in one reprint. These reprints will become available shortly.

During 1951 you'll find articles on estimating in just about every issue. Read them carefully and put them to profitable use in your business.

• • •

In 1950 Electrical Construction and Maintenance published 27 articles on industrial and commercial wiring and equipment installation?

Again during 1951 devoted attention will be given to wiring. For new techniques...time and cost saving methods . . . be sure to read these articles.

FOR SMOOTH BENDING . . .

choose your conduit from Central's Big 4

You can bend length after length of Central Conduit, and depend on its uniformity of physical structure necessary for quality bending. Bends are smooth, strong, easy to make.

All 4 types of Central Conduit are distributed by leading supply houses . . . "Cenlaco", hot-dipped inside and out . . . "Central White", electro-galvanized outside, black enameled inside . . . "Central Black", black enameled inside and out . . . and "Central EMT", the tough, lightweight steel conduit that's electrogalvanized outside, clear enameled inside.

All 4 types of Central Conduit are approved by Underwriters' Laboratories and the National Electrical Code, are products of our 111 years of tubular production experience.

Your supply house may be short of Central Conduit in the size and finish you require, but he'll do his best to supply you as promptly as possible, in spite of today's great demand.

CENTRAL SPANG CONDUIT

SPANG-CHALFANT

Division of The National Supply Company
GENERAL SALES OFFICE: Grant Bldg., Pittsburgh, Pa.
District Offices and Sales Representatives in Principal Cities

TYPE C

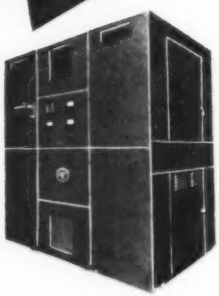
General purpose transformers, 600 volts and below; 1-15 KVA inclusive, single or three phase

HIGH efficiency

MARCUS DRY TYPE transformers

450 KVA, Type F Unit Substation, 4160 V. Delta, 60 Cycles, 3 ∅—120/208Y, 4 wire.

LOW maintenance



1500 KVA, Type F Unit Substation, 4800 V Delta 60 Cy, 3 ∅—120/208Y, 4 wire.

Years of specialization in the dry type transformer field have resulted in a far superior product. Being ahead of the rest of the field is the natural result of continuous effort and research in uncovering new materials which are your constant assurance of maximum transformer value.

MARCUS DRY TYPE, AIR-COOLED TRANSFORMERS

ARE SAFE — No explosion or fire hazards. No fire proof vaults. Class B and C heat proof insulations.

ARE ECONOMICAL — Lower cost installation and operation, negligible maintenance.

For the transformer that's second to none, specify MARCUS.

ONE OF THE WORLD'S LARGEST MANUFACTURERS OF DRY TYPE TRANSFORMERS EXCLUSIVELY

1 to 2,000 KVA up to 15,000 Volts to meet Individual Requirements

- DISTRIBUTION
- GENERAL PURPOSE
- UNIT SUBSTATION
- PHASE CHANGING
- ELECTRIC FURNACE
- RECTIFIER
- WELDING
- MOTOR STARTING
- SPECIAL

NEMA

Representatives in Principal Cities

MARCUS TRANSFORMERS CONFORM TO THE STANDARDS OF N.E.M.A. AND A.I.E.E.

MTC

MARCUS TRANSFORMER CO. INC.

39 MONTGOMERY STREET

HILLSIDE 5, NEW JERSEY

PIONEERS IN THE FIELD OF AIR-COOLED TRANSFORMERS

FOR THE RECORD

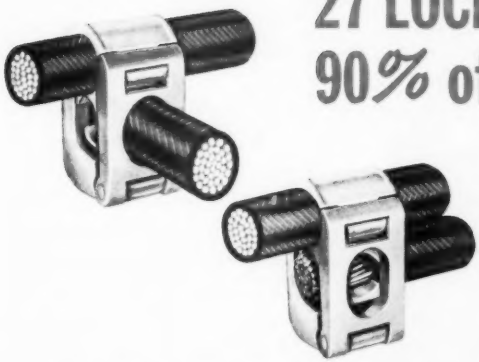
Did you know that this issue, with more than 100 pages of editorial material, packed full of forward-looking technical information and profit-building ideas, is the equivalent of a 400 page textbook?

Did you know that 229 advertisers have used this issue to bring you the latest information about products and services that will help you to do a better job ... more efficiently ... more profitably?

This issue is an outstanding example of America's industrial inter-communication system at work: editors and manufacturers working together, promoting the exchange of ideas, to keep you well informed and in step with the rapid cadence of electrical progress.

ELECTRICAL CONSTRUCTION AND MAINTENANCE

27 LOCK-TITE FITTINGS handle 90% of all wiring jobs!



Cut down your inventories—and installed costs too —with the T & B Lock-Tite line of T-Parallel Taps* • Terminals • 2-Way Connectors

With *just 27 pieces* from the T & B Lock-Tite line, you can: take tee or parallel taps off 1/0 to 1,000,000 CM mains, and hook them up to #2 to 1,000,000 branches; terminate or splice cables from #4 to 1,000,000; or make 90° elbows.

That means you can handle just about *any* wiring job—with the smallest inventories you've ever carried.

LOCK-TITES GO IN FAST— AND STAY PUT

Your installed costs go way down. For a main-to-branch connection, just slip the one-piece T-Parallel Tap over the main . . . slide in the branch. Tighten *one* screw with a key wrench . . . that's all there is to it! Lock-Tites go in to *stay* — built-in lock washer takes care of *that*. Thousands of them have been in service for years, without retightening.

ENGINEERED RIGHT— DISTRIBUTED RIGHT!

Lock-Tite T-Parallel Taps, Lugs and 2-Way Connectors are typical of the many T & B quality fittings recently re-designed to give you outstanding performance at lowest installed costs. Like all T & B fittings, they're furnished under the T & B Plan 100% through your local T & B distributor.

*patented

THERE'S A T&B ENGINEERED PRODUCT for every wiring job in the complete T & B line of fittings for all conductors and raceways.

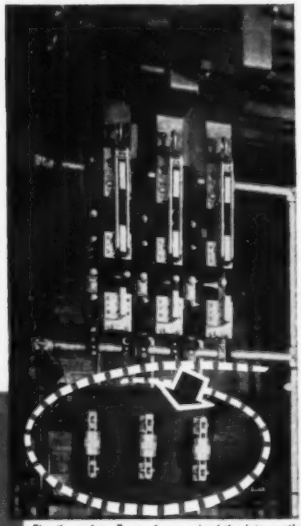
P. S. Hinjon Jr. T-Parallel Taps accommodate small taps from large mains*

THE THOMAS & BETTS CO.

INCORPORATED
34 Butler Street,
Elizabeth 1, New Jersey

MANUFACTURERS OF ELECTRICAL FITTINGS SINCE 1898

how to trap amperes and save circuits....



The three Amp-Traps shown raised the interrupting capacity of this 1600 amp circuit to 100,000 rms amperes @ 440 volts.

SHAWMUT Amp-trap*

AMAZING NEW CURRENT LIMITER

100,000 rms AMPERES INTERRUPTING CAPACITY

TWO-WAY PROTECTION

Amp-trap protects against *both* overloads and shorts on circuits up to 600V AC or DC. It is supplied in all standard ratings from 1 to 4,000 amps, and limits short circuit current on circuits where the available short circuit current may be as high as 200,000 amps.

STOPS SHORT CIRCUITS SHORT

Amp-trap puts a dependable new protective device in the hands of designers, engineers and architects. Lightning fast, it is directly responsive to the *rate of short circuit current rise.* In fact, *it is as fast as the circuit is fast.* This means positive overload and short circuit protection for switchgear, bussducts, motor starters, circuit breakers, and current transformers. What's more, with Amp-trap, you can now have low-cost protection for every service entrance on a network system.

APPROVALS

Amp-trap is listed by Underwriters Laboratories. Interrupting tests up to 202,000 amps at 500 Volts 60 cycles have been witnessed and certified by Electrical Testing Laboratories, Inc.

FOR OLD OR NEW SYSTEMS

There is an Amp-trap for every application. They are easily installed and quickly adapted to new or old equipment. Cost is so low that it is not an important factor.

WRITE TODAY. SEND FOR FREE BOOKLET ON AMP-TRAP.

*Trade Mark Registered.

You can get Amp-trap

THE CHASE-SHAWMUT CO.

371 MERRIMAC STREET • NEWBURYPORT, MASSACHUSETTS

DID YOU KNOW THAT...

Electrical Construction and Maintenance has a special department to handle your requests for technical and product information. It's properly entitled "READER SERVICE." Acquaint yourself with this department and the valuable service it offers. Properly used it can save you endless time. And today, time is money.

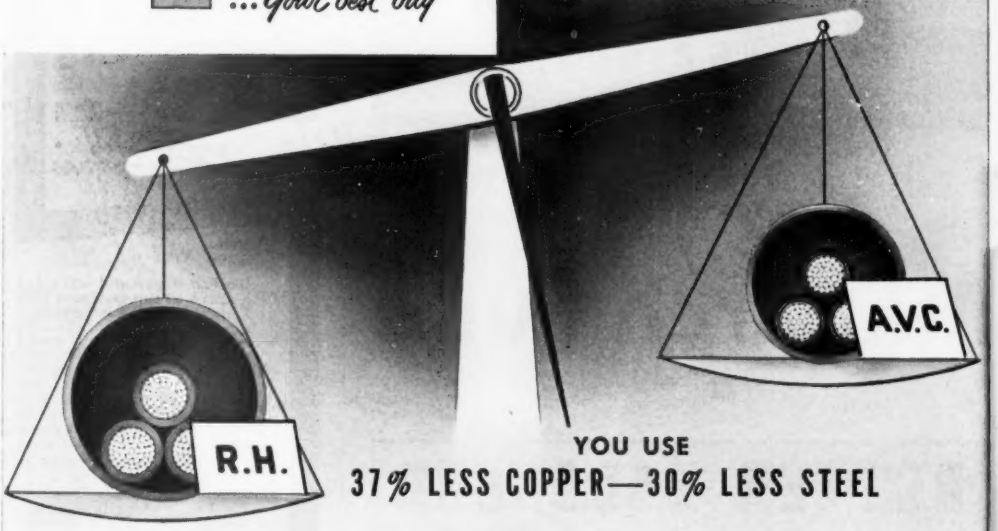
• • •

"Washington Report" is another special monthly editorial feature. It gives you an up-to-the-minute, authoritative picture of government happenings that will influence your business. Written by Berlon Cooper our Eastern Editor . . . who is also a special consultant to the National Production Administration . . . it is "must reading" for all electrical men who plan ahead.

Conserve Critical Copper and Steel

WITH Hi **ROCKBESTOS A.V.C.®**

...Your best buy



YOU USE

37% LESS COPPER—30% LESS STEEL

For a 430 ampere load, 3Ø, 3 wire, 40°C Ambient, 100' run—NEC chapter X

		TYPE RH	TYPE A.V.C.	
CONDUIT	SIZE	4 inch	3 inch	A saving of 327 lbs. of steel
	WEIGHT	1089 lbs./100'	762 lbs./100'	
CABLE	SIZE	500 MCM	500 MCM	A saving of 277.8 lbs. of copper
	WEIGHT	741 lbs./100'	463.2 lbs./100'	

Write for booklet "Rx for a Building with Hardening of the Arteries."

Hi $I=\frac{E}{R}$ *...Your best buy*

ROCKBESTOS PRODUCTS CORPORATION

NEW HAVEN 4, CONNECTICUT

Chicago, Detroit, Pittsburgh, St. Louis, Cleveland, New York, New Orleans, Los Angeles, Oakland, Calif.

NO
OVER PROTECTION
NO
UNDER PROTECTION

because this

Monarch Fuse

is

BETTER BALANCED

And **every** Monarch fuse is "better balanced" . . . to provide you with the **safest** electrical protection possible. This important feature means that you are fully guarded from two possible fuse faults . . . **over** protection **(excessive lags with resultant burned out equipment)** and **under** protection **(faulty fuses that burn out at less than specified loads)**. More and more responsible people in industry are realizing the value of "better balance" between these two extremes and the value of Monarch fuses in providing **sound, safe** protection. So specify . . . and insist on Monarch Fuse, — the fuse with the exclusive, fully approved MONO-LAG link. There's a dealer near you, — write for his name.

A COMPLETE LINE OF FUSES FOR INDUSTRY CONSTRUCTION & REPLACEMENT

Monarch FUSE CO., LTD.

118 E. FIRST ST. JAMESTOWN, N. Y.

Required: An electric ventilator *powerful* enough and *properly placed* to *really remove* steam, grease and odors.

Specified: **Blo-Fan***

Because:

Blo-Fan is powerful—The fan element in this patented Blo-Fan blade feeds a large volume of air to the blower element which expels it with great power. That's why Blo-Fan delivers more air at moderate, *quiet* speeds than either a fan or blower type ventilator . . . This feature alone has gained wider and more enthusiastic acceptance for Blo-Fan than anything else . . .

Because:

Blo-Fan is properly placed—Designed for ceiling installation or in any inside or outside wall, Blo-Fan cooperates with nature by capturing and expelling steam, grease and odors as they naturally rise . . . That's why Blo-Fan is placed directly over the point of air pollution . . . In the kitchen, bath, game room, laundry.

Because:

Blo-Fan has this switch—the 9-speed control on the Model 210 makes it as easy to control the rate of ventilation as it is to regulate the thermostat on a kitchen range.

The most imitated home ventilator in America

Manufacturers of Pry-Lites . . . the modern recessed lighting fixtures with snap-on fronts.
Stocked by more than 500 wholesalers in over 350 cities.

PRYNE & CO., Box 5-751 Pomona, California
Eastern Factory: Newark, New Jersey
Warehouses: Los Angeles, San Francisco, Chicago, Atlanta

*Trade Mark Reg.

THE
CONVENIENCE
OF

Uptegraff DRY TYPE Transformers

Saves money and Time for You!

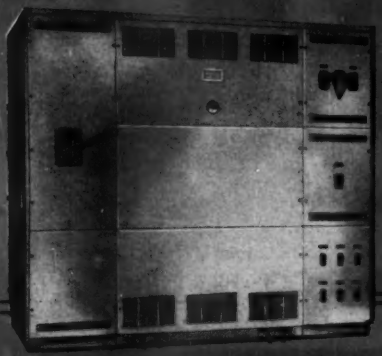
Because Uptegraff Dry Type Transformers are safe to install anywhere and are light in weight, they do not require special rooms, enclosures, heavy foundations or floor supports. Initial cost is low, installation is relatively simple. Long, expensive bus runs are avoided because they can be located at or near the load center.

Flexible in operation and safe for installation wherever desired, this Uptegraff Dry Type Transformer is economical and dependable. Unit shown is 333 KVA, single phase 2400/4160 Y-120 volts. Has four 2½% taps. View at left shows cover panels removed.

Uptegraff Dry Type Transformers are dependable and economical in service. The range of sizes includes transformers up to 2000 KVA, 3 phase, 15,000 volts.

R. E. UPTEGRAFF
MANUFACTURING CO.
Scottdale, Pennsylvania

The Uptegraff Unit Substation



Includes transformer and switching equipment in one compact, factory-wired, unit assembly. Designed and built to individual requirements.

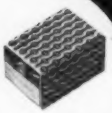
PAINE HANGING and FASTENING DEVICES

OFFER 3-WAY ADVANTAGES FOR YOU

Known for QUALITY and VERSATILITY

Paine Devices just can't pull loose so it's only natural they have become known and respected around the trade. Their many uses make them a must on every job.

Clearly marked packages for QUICK HANDLING



The convenient package sizes and distinct markings make Paine products easy to handle. You'll spend less time hunting for products and more time making sales.

Self-Selling MERCHANDISER

Make use of these convenient display merchandisers and watch your impulse sales climb. They take up little room on your counter yet are a big addition to your selling efforts.

The PAINE CO. 2961 Carroll Ave., Chicago 12, Ill.

Offices in Principal Cities

The Best Craftsmen Always Take PAINE'S

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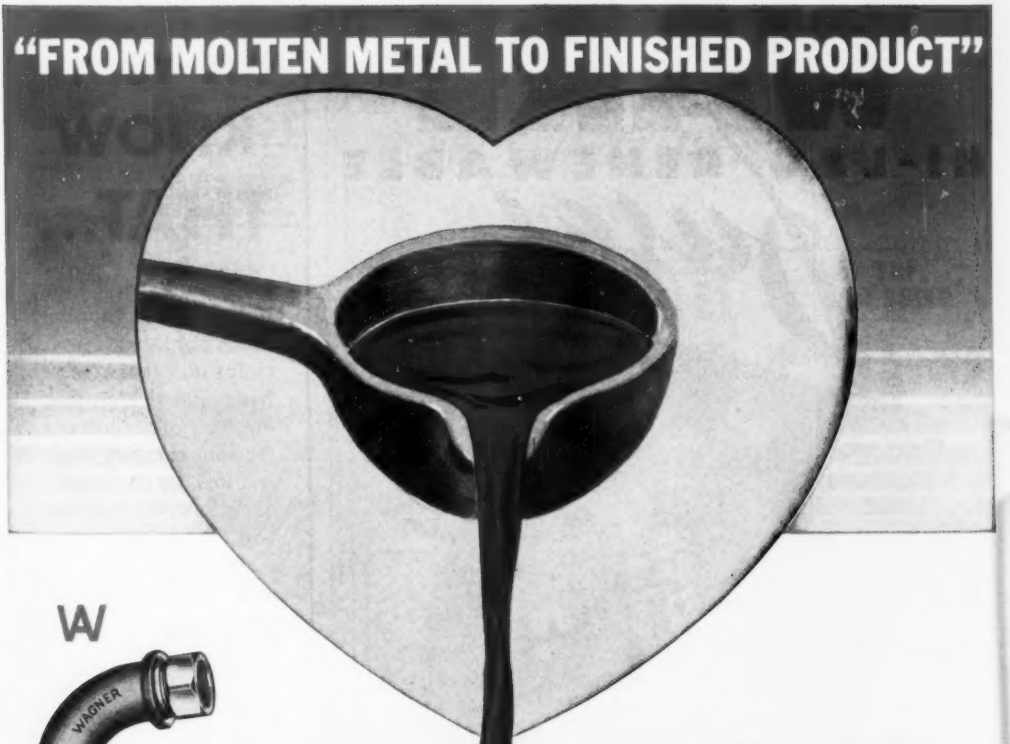
"FROM MOLTEN METAL TO FINISHED PRODUCT"



The Heart of Good Electrical Fittings

Every WAGNER Malleable Electrical Fitting for use with thin-wall conduit (EMT) illustrates the value of correct foundry technique and—years of specialization.

Facilities, men, and applied experience are fused together, here at WAGNER's, into a method and "way of doing things" that produces electrical fittings that are RIGHT and "good to work with".

You get tough, accurately cast fittings made in our own foundry under complete chemical laboratory control. Precision threading and finishing gives you malleable fittings of highest uniform quality.

Distributed nationally through leading wholesalers means "next-door" delivery to any part of the country. WAGNER MALLEABLE PRODUCTS CO., 222 W. Adams Street, Chicago 6, Illinois. Foundry and Plant, Decatur 60, Illinois.

Send for new illustrated Catalog 483

Approved by Underwriters' Laboratories, Inc.

WAGNER

MALLEABLE FITTINGS

"From Molten Metal to Finished Product"

WARE

HI-LAG RENEWABLE *fuses*

FIVE EXCLUSIVE FEATURES!

★ No. 1 Double Fibre Bridge Assembly increases strength 10 times. Maintains perfect alignment. ★ No. 2 Only one wrench needed to remove blown link and renew. ★ No. 3 Ruaged simplicity. Only 3 parts to handle in renewing link. ★ No. 4 HI-LAG Link of one piece, uniform thickness—engineered for specific capacity load, has large contact areas—wide body areas to insure dependable absorption of heat for time lag. ★ No. 5 Arched spring tension washers and heavy studded bolt, keeps links permanently tight. Reducing excessive heat and needless blows.

Write For

DESCRIPTIVE LITERATURE ON THE COMPLETE LINE OF WARE FUSES

WARE FUSE CORPORATION

4410 WEST LAKE STREET, CHICAGO 24, ILLINOIS

REPRESENTATIVES

Stanford Darger & Co., 328 W. 2nd South St. Salt Lake City 1, Utah

Test Instruments Unlimited, Box 5108, Portland 16, Ore.

Kenneth Anderson Co., 412 Seaton, Los Angeles 13, California

Hodges & Glomb, 1264 Folsom St., San Francisco 3, California

McGillan Sales Company, 513 South Amherst, Albuquerque, New Mexico

DID YOU KNOW THAT...

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• • •

In 1950 Electrical Construction and Maintenance published 27 articles on industrial and commercial wiring and equipment installation?

Again during 1951 devoted attention will be given to wiring. For new techniques...time and cost saving methods . . . be sure to read these articles.

Wedge-Grip® Connector

Split-Bolt Connector

HIGH RE-USE VALUE

- Strong
- Efficient
- Practical

Sherman® Solderless Fittings

S-O Type Solderless Lug

Maintenance engineers, faced with material and manpower shortages, are finding these Sherman Solderless Fittings the perfect answer to many problems. These fittings make quick, strong, permanent connections. They require no special tools — can be installed by less experienced men.

S-M Type Solderless Lug

And — equally important today, these fittings can be salvaged and re-used time and again, thereby reducing costs and saving precious copper.

Investigate the possibilities for the increased use of Sherman Solderless Fittings in your own work. Let us send you full specifications and prices now.

●

Write—for catalog showing the complete line of Sherman Electrical Specialties with engineering data and prices on each.

Set-Screw Connector

Sherman® ELECTRICAL PRODUCTS

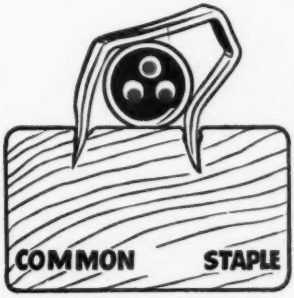
H. B. Sherman Mfg. Company
Battle Creek, Michigan

NOW! HERE'S THE FIRST IMPROVEMENT IN BX STAPLES IN 25 YEARS . . .

PROVED BY SERVICE — THIEL — FLAT TOP EASY TO DRIVE

BX STAPLES

(For Metallic and Non-metallic Cable)



Old Style Staples

bend, as shown in illustration, when hit hard. Also split the wood.

THIEL Proved

BX Staples are so improved in design that they drive straight, as illustrated —even in oak. Wood does not split.

WON'T SQUASH

The rugged Flat Tops are your bulwark against wasted time, materials, labor. Even under solid blows, they drive true. Your workmen will like them.

FOR ELECTRICIANS . .
FOR REFRIGERATOR MEN . .
FOR PLUMBERS . .

THIEL EASY DRIVE "NAIL IT"

They're rugged, won't bend. Serrated teeth hold them secure. The Cadmium plating keeps them rust proof. Packed in cases.

THIEL "EASY ON" STRAPS

Made for ½-inch, thin walls. Hold any job rigid. Will pass inspection. Cadmium plating makes them rust proof. Packed in cases.

DRIVES TRUE

Use THIEL BX Cable Staples and you will find them a vast improvement over any other BX Staples you ever used.

TAKES PUNISHMENT

They are scientifically engineered to absorb the full stress of blows from the hammer. The sharp right-angle bends on the head permit these staples to drive straight and true.

Send for FREE samples.

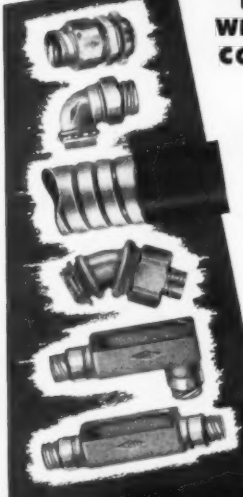
- SAVE TIME
- MATERIAL
- LABOR

• Sold by Leading Electrical Wholesalers Everywhere •

THIEL TOOL & ENGINEERING COMPANY
1417 NORTH MARKET ST., ST. LOUIS 6, MISSOURI

Use Vap-oil-tite

WHERE OIL AND VAPOR TIGHT CONNECTIONS ARE REQUIRED



VAP-OIL-TITE is the Complete Liquid and Vapor Proof Fitting with a threaded positive grounding bushing designed exclusively for Plastic Covered Flexible Metallic Conduit used for machinery and equipment wiring. No other parts are necessary to make sure sealed connections.

Write or wire today for descriptive bulletin #MT-102 giving types, sizes and prices.

SIMPLET ELECTRIC COMPANY
3600 Potomac Ave. • Chicago 51, Illinois
11 Park Place • New York 7, New York

HEX NUT CONNECTOR *for* SERVICE ENTRANCE CABLE

- Tapered rubber bushing provides tighter seal around cable.
- Locking device keeps bushings from turning when being tightened.
- Uses compound to seal rubber bushing from atmosphere for permanent seal.
- Also furnished in compound filled — a single fitting taking ¾ to ⅞ oval cable.

M. & W. Electrical Fittings can provide a savings in time and money. Your installation requirements can be filled right from the items shown in the M. & W. catalog—and you'll find they are designed for speedy installation.

- GROUND CLAMPS
- SERVICE HEADS
- SERVICE ENTRANCE KITS
- CONNECTORS

M&W Electrical Fittings
The M. & W. ELECTRIC MFG. CO., Inc.
EAST PALESTINE, OHIO

DID YOU KNOW THAT...

Electrical Construction and Maintenance has a special department to handle your requests for technical and product information. It's properly entitled "READER SERVICE." Acquaint yourself with this department and the valuable service it offers. Properly used it can save you endless time. And today, time is money.

• • •

"Washington Report" is another special monthly editorial feature. It gives you an up-to-the-minute, authoritative picture of government happenings that will influence your business. Written by Berlon Cooper our Eastern Editor . . . who is also a special consultant to the National Production Administration . . . it is "must reading" for all electrical men who plan ahead.

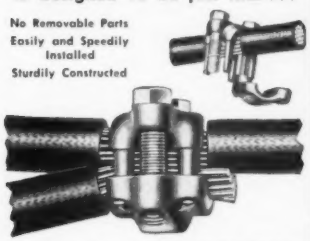
CLAMP AND LOCK YOUR CONNECTIONS { THE **K&H** WAY

This

SWIVEL U-BOLT CONNECTOR

is designed to do just that...

No Removable Parts
Easily and Speedily Installed
Sturdily Constructed



MEET ALL REQUIREMENTS

85% Copper Alloy • Ample Strength
High Conductivity • Unaffected by Vibration
Moisture Resistant
Sizes Up to 1,000,000 CM.
Approved by Engineers

Specify K&H for YOUR Next Job

For More Details, Sizes and Prices
WRITE FOR CATALOG 5LC

KRUEGER & HUDEPOHL
232-8 VINE ST. • CINCINNATI 2, OHIO

after you've read this magazine

. . . and clipped pertinent ideas, articles and advertisements for reference, *please do not burn or throw it away.*

Here are two sound reasons why:

1) Wastepaper can help to swell the funds of your local Boy Scout Troop, your church or other community organization. It gets a good price these days.

2) Whether in magazine form or not, wastepaper helps to fill the increasing need for paper pulp brought on by the mobilization effort.

Collect it. Give it to your favorite organization. Chances are they have scheduled pick-ups.

When office modernization increases the need for more available outlets

It's a fact, the modern office today depends more than ever before on electrically operated business machines. If you are presented with the ever-growing problem of providing closely-spaced, correctly located outlets for the handy plug-in of electric typewriters, dictating machines, tabulating machines, desk lamps, (and for the electrical equipment in your drafting room and engineering department, too) . . . your answer is 1900 PLUGMOLD. Easy to install on the surface above baseboard or at chair rail height, 1900 PLUGMOLD is ideal for original wiring in new construction and the extension of present circuits in existing buildings. No longer any need for multiple plugs, unsightly extension cords or makeshift hookups with PLUGMOLD... the safe, attractive way to make those necessary wiring improvements. Modernize wiring the modern way... install PLUGMOLD.

3 BASIC PLUGMOLD SYSTEMS

1900 — Light duty plug-in-anywhere wiring system, for outlet convenience. Available wired, unwired or as SNAPICOIL.

2100 — A plug-in-anywhere wiring system with a capacity larger than 1900. Furnished unwired.

3000 — Heavy duty plug-in-anywhere system for industrial applications. Also serves as branch feeder system.

THE WIREMOLD COMPANY
HARTFORD 10, CONNECTICUT

7WM81

NEARLY EVERY WIRING JOB YOU PLAN CAN USE

KEYSTONE

WIREWAYS AND AUXILIARY FITTINGS

PERMITS FASTER, NEATER, SAFER WIRING INSTALLATIONS.
FULLY APPROVED BY UNDERWRITERS' LABORATORIES, INC.

KEYSTONE
known for quality to

ARCHITECTS
AND ENGINEERS

CONTRACTORS

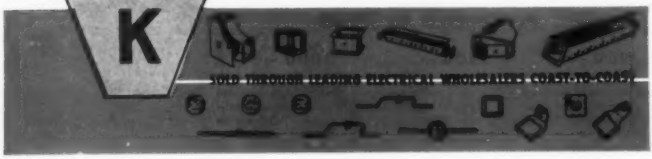
CHIEF ELECTRICIANS

If you're looking for extra profits on the wiring jobs you sell, you'll find they're easily earned simply by offering your customers Keystone square WireWays and auxiliary fittings. For the Keystone line is the *quality* line that fits naturally into almost any electrical distribution system. Provides durable, dependable, permanent protection for main power lines . . . for feeders, branch circuits, control and signal wiring systems. Quickly, easily installed . . . saves time, facilitates electrician's work. Adaptable to any layout . . . assures a neater, nicer, more flexible job as compared with piping and other improvised means.

So, for greater service to your customers . . . and extra sales and profits for you . . . make sure you specify Keystone—Interchangeable Square Wireways, 2½" x 2½", 4" x 4", 4' x 6", and 6" x 6" in 1', 2', 3', 4' and 5' lengths, flangeless with screw-covers or with flanges and hinge covers plus auxiliary fittings. Complete line of bar hangers and outlet boxes also available. Send for fact-filled Keystone Specifications Catalog.

MANUFACTURERS' REPRESENTATIVES: *Still a few good Keystone territories open to experienced men. Write today for complete details.*

KEYSTONE MANUFACTURING COMPANY
23328 SHERWOOD ROAD • CENTER LINE (DETROIT), MICHIGAN



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Did you know that 229 advertisers have used this issue to bring you the latest information about products and services that will help you to do a better job . . . more efficiently . . . more profitably?

This issue is an outstanding example of America's industrial inter-communication system at work: editors and manufacturers working together, promoting the exchange of ideas, to keep you well informed and in step with the rapid cadence of electrical progress.

ELECTRICAL CONSTRUCTION AND MAINTENANCE

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IMPORTANT:

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ONE GOOD JOB LEADS TO ANOTHER WHEN YOU INSTALL

KEYSTONE

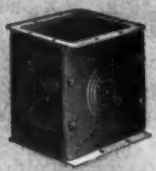
WIRING INSTALLATION EQUIPMENT

KEYSTONE WIREWAYS

Flanged with hinged cover. Available in 2½" x 2½" 4" x 4" and 6" x 6" sizes. Standard lengths up to 5'. Flangeless with screw cover also available.

KEYSTONE 90° ELBOW AND PULL BOX

"Smoothflow" inside radius to facilitate drawing wire through. Sizes: 2½" x 2½", 4" x 4" and 6" x 6".



KEYSTONE JUNCTION BOX

May be used in place of more expensive T's, L's and Crosses in addition to customary junction box application. Sizes: 2½" x 2½", 4" x 4" and 6" x 6".

KEYSTONE UNIVERSAL DROP HANGER

For suspending wiring troughs from overhead. Mounting screws and nuts furnished. Sizes: 2½" x 2½", 4" x 4" and 6" x 6".

KEYSTONE BAR HANGER-BOX ASSEMBLIES

Shallow and deep bar hangers in standard or special lengths. Available separately or with BX or Romex outlet boxes assembled.

KEYSTONE OUTLET BOXES

4" octagon boxes made of 14 gauge steel with ½" or combination ½" and ¾" knockouts, or BX or Romex clamps with nested fit for quick and easy pulling of wires to reduce installation costs.

WIREWAY REDUCING BUSHING

Provides quick, convenient means of effecting reduction from 6" x 6" to 4" x 4" to 2½" x 2½" Wireways without disturbing appearance or efficiency of the job.

Here are just a few of the "plus-value" items found in Keystone's Quality Line of wiring installation equipment. Many others also available to complete the requirements of all residential, commercial, and industrial electrical systems . . . all described and illustrated in the fact-filled Keystone Specifications Catalog. Write for your copy today.

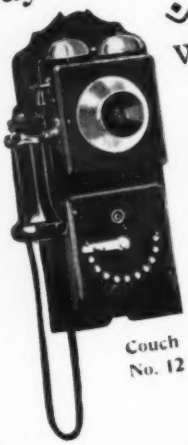
Stocks of standard items maintained for immediate delivery. Special equipment quickly made to customer specifications.

KEYSTONE MANUFACTURING COMPANY

23328 SHERWOOD AVE. • CENTER LINE (DETROIT), MICHIGAN

Reprinted from the April, 1903 edition of The National Electrical Contractor — now Electrical Construction and Maintenance

Say! Mr. Contractor,



We make the Best Telephone

To be had at any price.
Have you MET our Number 12?
A generous acquaintance with it will do you good.
Nothing half as good made elsewhere.
Our Bulletins are descriptive and show diagrams.
Get your name on our Mailing List.

Couch No. 12

S. H. COUCH CO., 158 Pearl Street. BOSTON Mass.

Say MR. CONTRACTOR

Our phones (see opposite page) and our advertising, too have come a long way since this memorable ad appeared nearly 50 years ago.

But through all these many years there's one thing that hasn't changed: The integrity of the Couch name. Leading contractors all over the world (perhaps you are among them) recognize Couch as a pioneer and leader in the manufacture of quality communication equipment . . . know that every Couch Product offers a full measure of value for each dollar spent.

S.H.COUCH CO., INC.
DEPT. 807 NORTH QUINCY 71, MASS.

Private telephones for home and office . . . hospital signaling systems . . . apartment house telephones and mail boxes . . . fire alarm systems for industrial plants and public buildings.

KNOW YOUR WHOLESALER ...BETTER

One of the most important contacts the electrical contractor and industrial electrician has is the electrical wholesale distributor. He is the one who stocks the necessary electrical equipment and supplies needed to make an installation quickly, completely and profitably.

But this is only half of the story. Today, with industrial mobilization shifting into high gear . . . with flash shortages throwing work schedules out of kilter . . . electrical wholesale distributors and their salesmen can render other vitally important services: point out those activities that will be permitted to proceed at full speed . . . where and how to get the most business out of sub-contracting and new plant programs related to the Defense Production Act . . . explain the outlook for products containing controlled materials . . . manufacturers' production plans, allocations, new designs and the use of substitute materials.

Electrical wholesale distributors and their salesmen, with a backlog of World War II experience, are well informed, strategically located and completely equipped to serve the needs of electrical construction and maintenance men throughout the country.

Better than 9 out of 10 electrical wholesale distributors get their information from

ELECTRICAL WHOLESALING
The National Magazine of Electrical Wholesale Distribution

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they're NEW.. they're NEWS!

COUCH SCORES AGAIN WITH PRODUCTS DESIGNED TO FIT YOUR NEEDS . . . AND COSTS!

Two new phones to keep pace with modern architectural planning in offices and apartments.

New HANDSET PHONE

Really modern intercom convenience for selective talking and ringing . . . 13 - 20 station systems.

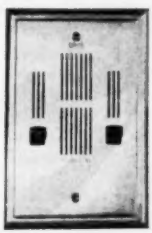
- Rotary type switch for easy station selection
- Compact terminal box provides all wiring connections
- Schools, offices, factories, hospitals are all prospects

New CORDLESS SUITE PHONE

Modern flush mounting apartment phone with standard (2½") box or shallow (1½") box for thin wall construction.

- Standard face plate — satin stainless
- Front connection for all wiring — ample wiring space
- Audible signal — buzzer or chime, or both
- Models for one or two talking circuits — one to five signalling circuits

Write today for additional information. Nearest Couch Representative will assist you.



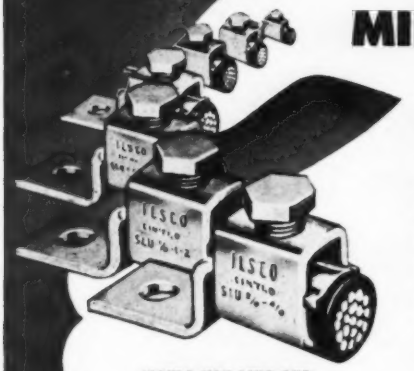
S.H.COUCH CO., INC.

DEPT. 807 NORTH QUINCY 71, MASS.

Private telephones for home and office . . . hospital signaling systems . . . apartment house telephones and mail boxes . . . fire alarm systems for industrial plants and public buildings.

ILSCO CONNECTORS

MILLIONS...



YES, **MILLIONS** *used since 1936 have proved their dependability*

WOULD YOU LIKE OUR 80-PAGE MANUAL?

ILSCO
COPPER TUBE & PRODUCTS, INC.
5741 MARIEMONT AVE.
CINCINNATI 27, OHIO

EXPLOSION-PROOF BELLS

The bell that does not fail. Full, resonant, distinctive, sustained tone . . . great carrying power.
Fully enclosed mechanism . . . by the Originators of Underdome Bells.
All mechanical parts fully protected against atmospheric corrosion.
Underwriters' Listings: Class I, Group B, C, and D. Class II, Groups F and G.
Wheelock BELL
PAINTS AND VARNISHES
CHEMICAL PLANTS
PETROLEUM INDUSTRIES

SOLD THROUGH ELECTRICAL WHOLESALERS

WRITE FOR BULLETIN EP

Wheelock SIGNALS

SIGNAL
ENGINEERING & MFG. CO.
154 WEST 14TH ST. NEW YORK 11, N.Y.

DOUBLE BARREL Advertising

Advertising men agree—to do a complete advertising job you need the double effect of both Display Advertising and Direct Mail.

Display Advertising keeps your name before the public and builds prestige.

Direct Mail supplements your Display Advertising. It pin-points your message right to the executive you want to reach—the person who buys or influences the purchases.

More and more companies are constantly increasing their use of Direct Mail because it does a job that no other form of advertising will do.

McGraw-Hill has a special Direct Mail Service that permits the use of McGraw-Hill lists for mailings. Our names give complete coverage in all the industries served by McGraw-Hill publications—gives your message the undivided personal attention of the top-notch executives in the industrial firms. They put you in direct touch with the men who make policy decisions..

In view of present day difficulties in maintaining your own mailing lists, our efficient personalized service is particularly important in securing the comprehensive market coverage you need and want.

Ask for more detailed information today. You'll be surprised at the low over-all cost and the tested effectiveness of these hand-picked selections.

McGRAW-HILL PUBLISHING CO., INC.
330 West 42nd Street
NEW YORK 18, N. Y.

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ELECTRICAL CONSTRUCTION AND MAINTENANCE

ILSCO COPPER TUBE & PRODUCTS, INC.
5741 MARIEMONT AVE. CINCINNATI 27, OHIO

THAT THE HEART OF YOUR DISTRIBUTION SYSTEM HAS:

1. *TOP EFFICIENCY*
2. *EASY ACCESSIBILITY*
3. *LONG LIFE*

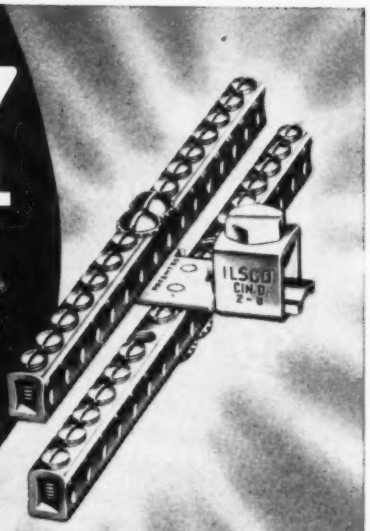
Buy Standard and have your transformers tailored exactly to your needs, with accessories of your own choosing. Our complete consulting and engineering facilities are at your service.

Phone your Standard representative today or write us direct for prompt individual attention.

THE STANDARD TRANSFORMER COMPANY
WARREN, OHIO • OFFICES IN PRINCIPAL CITIES

ILSCO NEUTRAL BARS

save time and money and above all, get better connections.

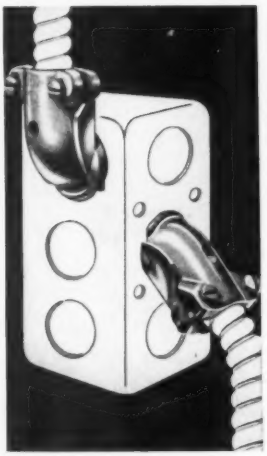


DO YOU WANT OUR 80-PAGE MANUAL?

ILSCO COPPER TUBE & PRODUCTS, INC.

5741
MARIEMONT AVE.
CINCINNATI 27, O.

Looking for a good *Connection?*



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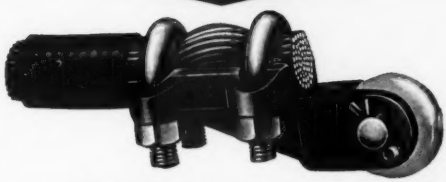

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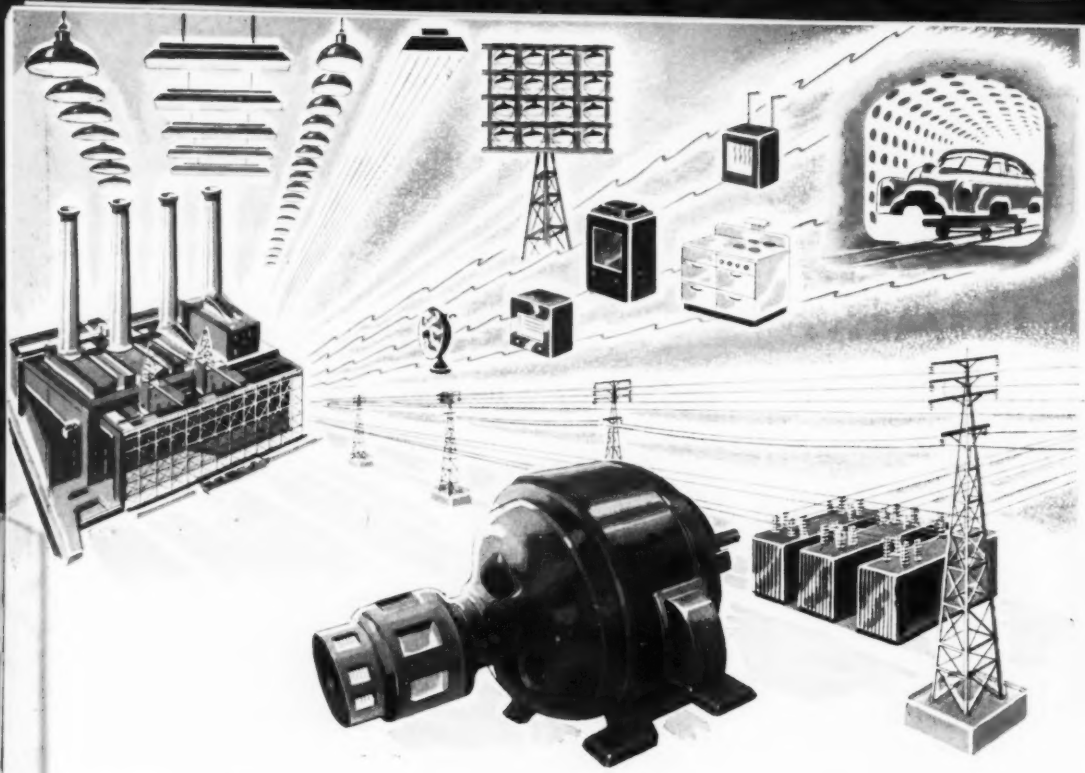


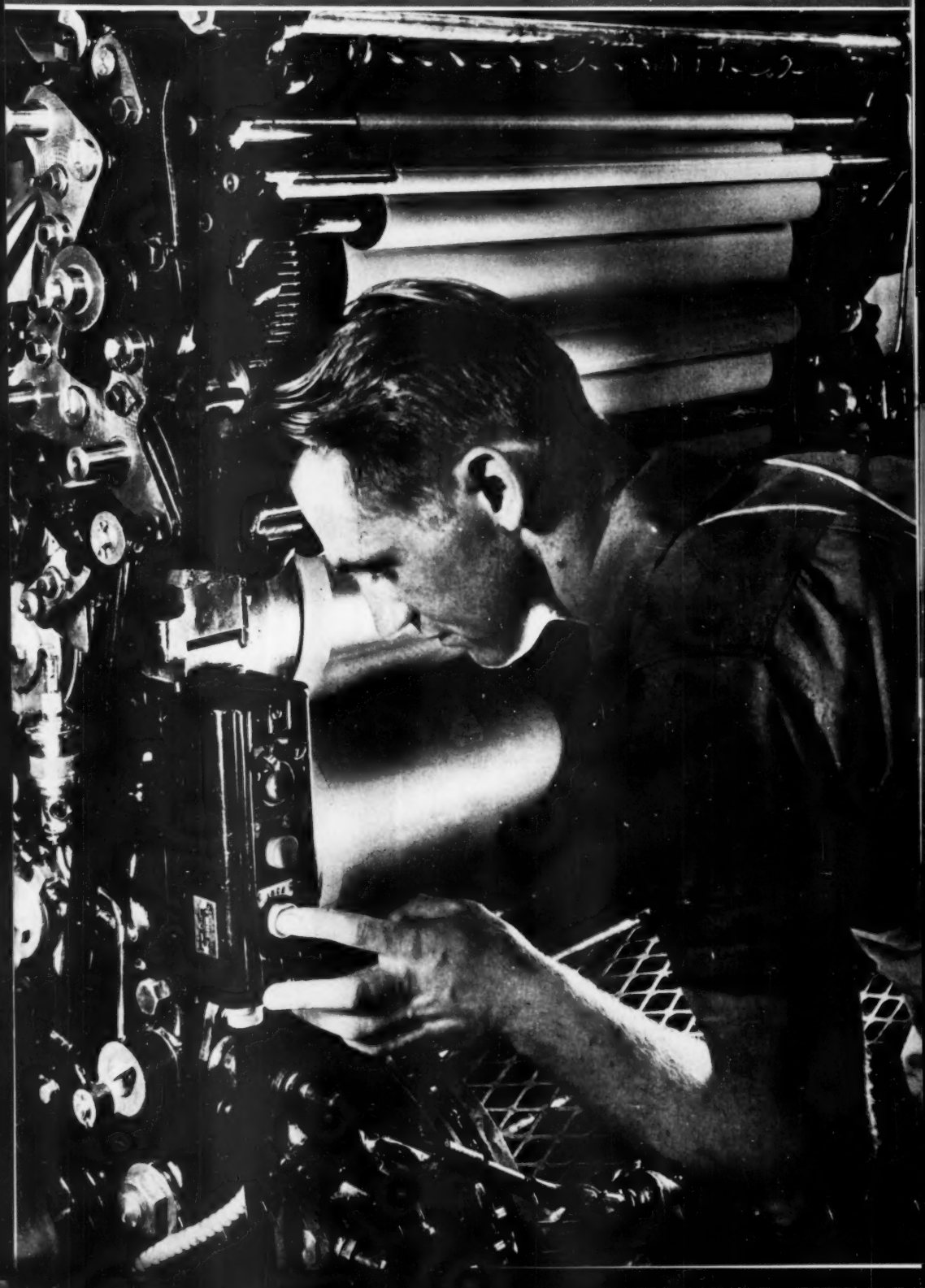
Utilization Trends

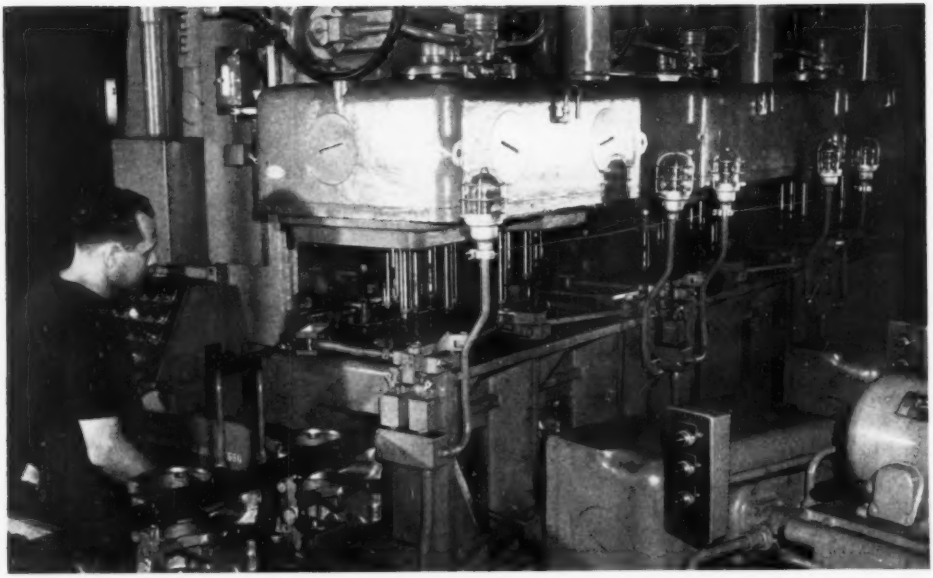
FRONTIERS in power, heat and light are moving forward under the pressures of prosperous times, industry ingenuity and an evidently insatiable public demand for the benefits of modern electrification. The cost of energy has been held down during a long inflationary spiral with the result that electrical energy has gained powerfully in competitive position with respect to other methods and fuels.

Unchallenged in power and light, electrical energy is moving with characteristic initiative into the field of heat. It holds a long lead in refrigeration and air conditioning. It is gaining ground in commercial cookery and, even more rapidly, in process heating in industry. It is piling up phenomenal statistics in domestic cooking and water heating. And, in a few areas, electrical industry people are prying their way into space heating, a staggering potential market.

In motors, the spectacular developments are at the extremes of size and speed; tiny instrument motors, irrigation pump motors of several thousand horsepower and motors which operate at speeds of the order of 100,000 rpm. But the trends of practical importance are better exemplified by totally enclosed designs, welded frames and improved insulations. The efficiency of the high speed motor is compactly applied to low speed applications by means of the gear motor. Adjustable speed drives, amplidynes and electronic controllers are greatly extending the area of speed control.

Lighting has made spectacular progress since the introduction of the fluorescent lamp. The better modern work is so far ahead of past standards that relighting alone has enormous potentials for the electrical industry. As for future developments, the sky is the limit.





MODERN AUTOMATIC metal working is an advanced frontier of industry. Here castings flow into a huge progressive machine tool, flow out as nearly finished transmission cases. Operation is fully automatic.

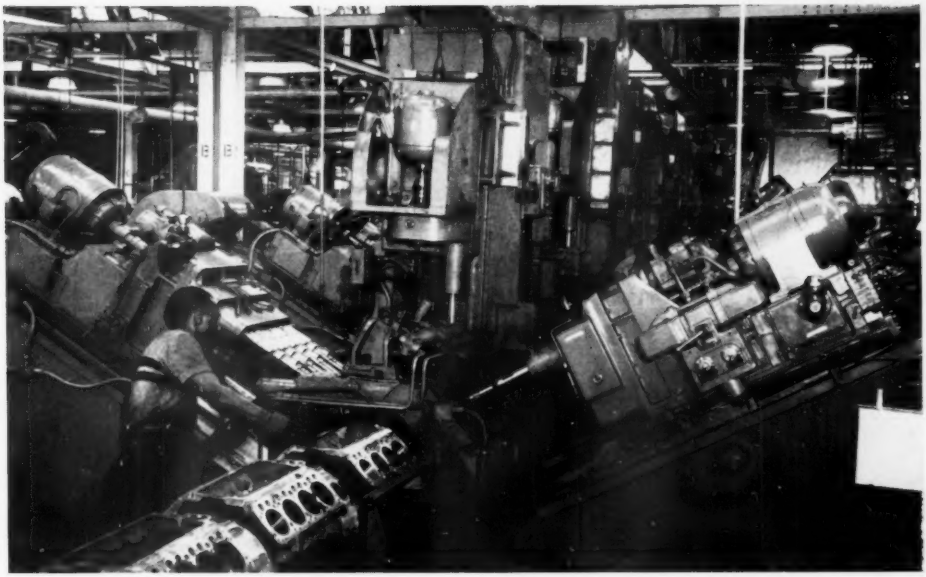
Motors and Controls

Motive power under control is a major area of advancing utilization. Trends are toward better performance, adaptability and more automatic control.

THE polyphase induction motor is, and probably will continue to be, the conventional motive force for industrial machinery. It is mechanically simple, stable, trouble free in normal use and exceptionally rugged. Modern developments have tended toward improved enclosures, bearings and insulations.

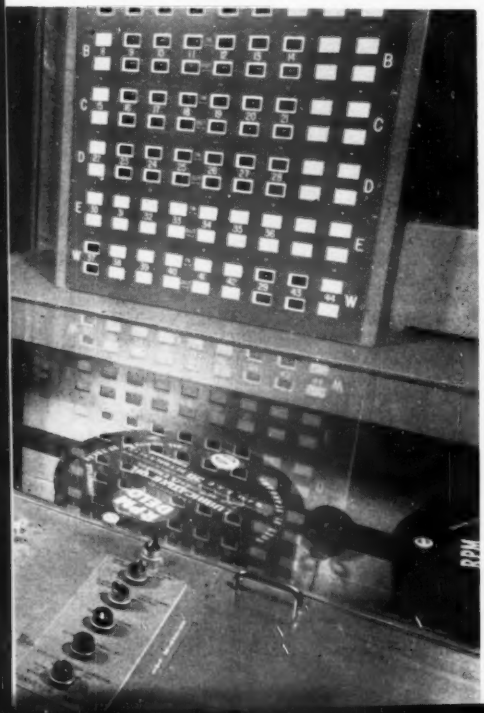
The trend in application is toward complete enclosure and protection of the electrical and working parts. Totally enclosed motors can be used under most industrial conditions, and outdoors without extra protection. Fan cooling gives reliable temperature control.

The types of motors widely used in modern power applications include the versatile wound rotor polyphase motor for applications requiring low starting current, adjustable speed, reversing and high starting torque. The repulsion start induction motor combines high starting torque with low starting current for single phase application. The capacitor start single phase motor gives high starting torque at normal starting current. The synchronous motor combines



FROM INDIVIDUAL DRIVE, motor application is moving in the direction of many motors interlocked by control in a single machine, and operated on predetermined cycles.

CENTRAL DISPATCHING and control for an extensive conveyor system in a refinery package and grease plant, typical of trends to central remote control of industrial operations.



high efficiency and constant speed with its peculiar ability to correct power factor at the same time.

Improved designing, insulations and varnishes have bettered the performance of electric motors in a great many applications. Glass and silicone insulation have permitted windings to operate satisfactorily at very high temperatures. Sealed bearings have lowered maintenance cost by eliminating a large part of routine care.

STARTERS AND CONTROLS

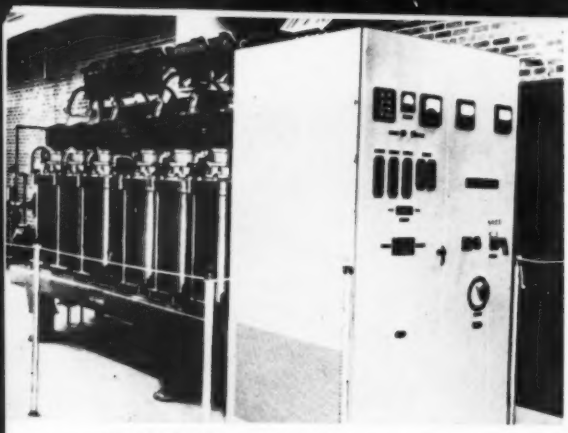
Current developments in magnetic motor starters are toward compact constructions, ease of wiring, and better contact surfaces. The rigors of military use brought many improvements in impact resistance and reliability under severe operating conditions.

Since most induction motors are designed for full voltage starting, line starters are most widely used. Manual starters are common up to 10 hp. The trend, however, is definitely toward magnetic starters for all types of control application. Magnetic starters can be located for best wiring convenience, and control points located for best operating convenience.

For reversing, two contact assemblies are interlocked mechanically and electrically. For reduced voltage starting, two sets of contacts are also used, one to connect to the line through resistors or reactors and the other to short out the impedance devices after a time interval.

By bringing together operating, monitor and speed adjustment circuits, entire systems of motors can be operated or supervised from a central point.

By the use of auxiliary contacts and timing devices,



HEAVY DUTY excitron rectifier in a transit substation provides 600 volts dc at 2000 kw.

ELECTRONIC adjustable speed motor controls, at left, for a rotary molder and figbar machine. Upper cabinets contain the control equipment, and the tube anode transformers are mounted below.

motor starters can be interlocked or operated in sequence.

RECTIFIERS

In the early days of electricity, dc was generally used for power. As ac generation and distribution supplanted the early dc circuit, ac motors took over most of the power loads. Some of this changeover, in older metropolitan areas, is still going on.

There are many power applications which require, or work better, on dc. Plating, magnetic chucks and certain wide range speed adjustments are some of them. The manufacture of aluminum takes huge quantities of direct current energy.

Conversion of available ac to direct current for industrial use is handled by a widening variety of methods, each with advantages for particular requirements.

The rotary converter and the motor generator are well known methods of conversion. A new mechanical contact rectifier for up to 10,000 amperes at 50 to 400 volts has recently been developed with efficiencies of 95% or better. Saturating reactors spread the zero point in the sine wave, and commutation takes place when no current is flowing. The first two I-T-E American units went into operation at the Buffalo Electrochemical Co. in 1949 and showed 96.6% efficiency.

Dry plate rectifiers of copper oxide and selenium are widely used for local sources of dc. They are often applied in communication equipment, battery chargers and for moderately heavy currents at low voltage.

Mercury arc and electronic rectifiers are usually applied where moderate currents at higher voltages are required and for very heavy currents the ignitron gives efficiencies of 95% and over.

ELECTRONIC CONTROL

The growth of electronic control applications is impeded only by process or equipment designs, to make economical use of the tremendous versatility of electronic equipment. Practically any control problem can be handled by electronic apparatus; however, it usually becomes economically advantageous under certain conditions:

1. Where the control must respond to very small values, differences or narrow thresholds.
2. Where the control must not load or impede the initiating device.
3. Where the control must act with great speed.
4. Where small or precise intervals of time are important.
5. Where equipment must be accurately self-regulating.
6. Where fully automatic operation is desired.

These by no means limit the probable application of electronic control, but, at the present frontier, adaptation is usually encouraged by one or more of the above conditions.

While apparatus for any control application can be specially designed from a very wide range of parts and components, in practice, electronic control is usually provided from a group of readily available engineered products which, with appropriate selection of input and output equipment, meet most requirements.

The electronic relay serves where control must respond to very small values. A typical unit is totally enclosed in a rugged steel case and operates from a 115 volt ac supply. A two wire input will respond to a circuit with 500,000 ohms resistance or from delicate contact making instruments. It can respond to contact closure time as short as .004 seconds. An electronic amplifier energizes an electromagnetic relay with single pole double throw contacts, rated at 1 ampere, to energize the control circuit of a conventional magnetic contactor, signals, lights, solenoid valves, counters or other equipment.

A typical use of the electronic relay is as a thread break stop in textile mills. On beamer-reeling equipment, the motor must be stopped if one of many hundreds of threads break. Each thread is passed through an eyelet on a very light hinged lever. On a break, the lever drops to strike a contact bar. The presence of thread dust makes this contact widely variable in resistance; but, since the electronic input circuit can respond on much higher resistance than is likely to be encountered, reliable operation is provided.

Delicate contacts are sometimes incorporated in electrical instruments for process controls. The controlled devices usually require control currents beyond the capacity of these contacts. The electronic relay can respond readily to very delicate contacts without overloading them.

The photoelectric relay is a special form of the electronic relay and employs a light sensitive element as the control input. As such, it is particularly useful for applications involving condition 2, above, since a light

beam can operate it without loading or impeding the initiating device. It is also adaptable where the control must reach out across a floor or assembly line.

The photoelectric relay is widely used for counting objects on a conveyor line, for controlling door operation, paint sprayers and infra-red drying ovens and for safety guards. Like the electronic relay, they are rugged and inexpensive and may also be used to advantage in many applications where only a tiny fraction of the potential sensitivity of the apparatus is needed.

In many types of resistance welding, the current flow must be measured out with high precision. This requires high speed switching and an accurate time measure, two of the above conditions. So electronic control is widely used. Electronic contactors can be operated on a single cycle. Precision timers can measure out exact numbers of cycles with accurate heat adjustment.

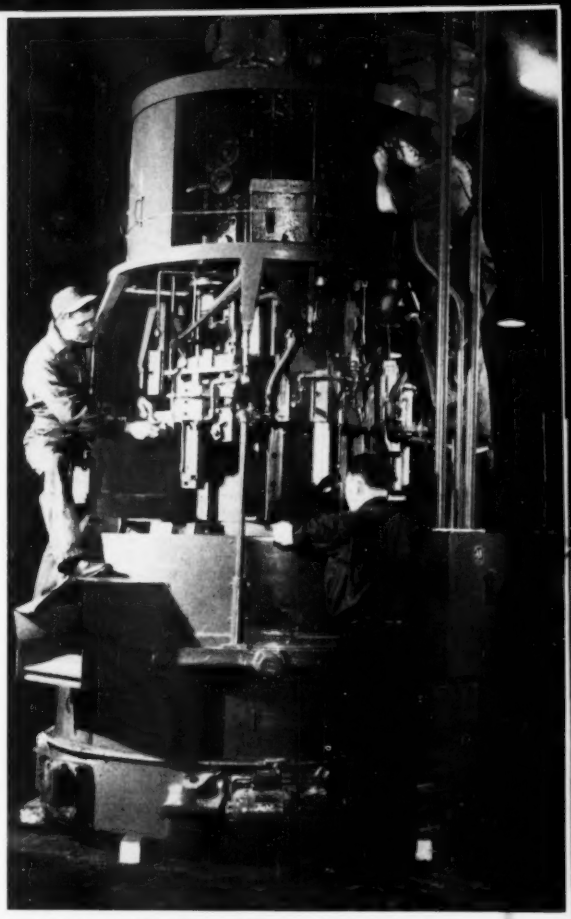
Where precise speed control and adjustments are required, electronic controllers will meet exacting conditions. A typical adjustable speed drive takes ac supply through a controlled rectifier to a dc drive motor. The electronic control element will hold a set speed under varying load, control the rate of acceleration to speed change, provide jog or creep and respond to automatic signals. It will respond accurately to several preset speeds, and several motors can be coordinated under one control.

REMOTE CONTROL

Remote control covers a great many simple and complex control circuits. It provides for operating equipment from a location removed at some distance from the power actuating apparatus.

One area of remote control of rapidly growing importance is in remote positioning. A simple example is a rotating device on a TV antenna. This may consist of a pair of Selsyn motors. Manual rotation of one is promptly followed by a similar rotation of the other through the same angle and in the same direction. Similar devices provide remote meter indications.

By isolating the initiating device by means of an electronic amplifier, torque amplification is provided. The position of the input is precisely followed at the output but with much greater force.



BULLARD AUTOMATIC machine tool during assembly. It performs sequence operations under precise program controlled electric drives.

AUTOMATIC CONTROL

Many industrial processes can be speeded or made more accurate if the limitations of human response can be avoided. Some require a consistency of response or a quick accuracy of measurement beyond human skill. Some processes involve dangerous materials, which must be skillfully manipulated. For these and many others, the electrical industry has developed automatic controls with unlimited horizons of possible future application.

Great advances in this field have been made in very recent years, particularly in military equipment. In the ordinary "open end" control system, for example, a variable speed controller on a motor, operating a pump which must be held to a precise quantity of liquid per minute, the operator observes the quantity flowing, compares it with the desired flow and manually adjusts the controller to correct the difference.

The essence of automatic control is that means are provided, 1) to detect the difference between the desired and actual performance; 2) to feed this information back to the control point; and 3) to so operate the control and apparatus as to reduce the difference to a minimum. Thus, automatic control performs in much the same way as the manual operator; however, with refined apparatus, automatic methods can respond with very great speed, with precision and with consistency.

An ordinary cellar pump is an example of automatic control. A float rises with the water. When a certain level above normal (difference between desired and actual performance) is reached, it trips a switch (feeds this information to the control.) The motor operates to reduce the level of the water (reduce the difference between actual and desired performance).

By reducing the motion permitted to the float, the level can be brought closer to that desired, operating the pump more frequently and for shorter periods. Refining further, the float can be mounted on the arm of a speed controller and the rate of pumping speeded or slowed to hold a constant level.

If a "closed" system has the characteristics of automatic operation and error correction and, in addition, a power gain is introduced, it is known as a servo mechanism. An automatic profiling machine tool is a typical servo mechanism. A contour pattern is followed automatically by a cutting tool. The mechanism operates to reduce the difference, and the cutting tool is applied with great force.

March of Electric Heat

Definitely on the up swing are industrial uses of enclosed heating elements, self contained space heaters, infra-red and tempered glass units, and high-frequency heat.

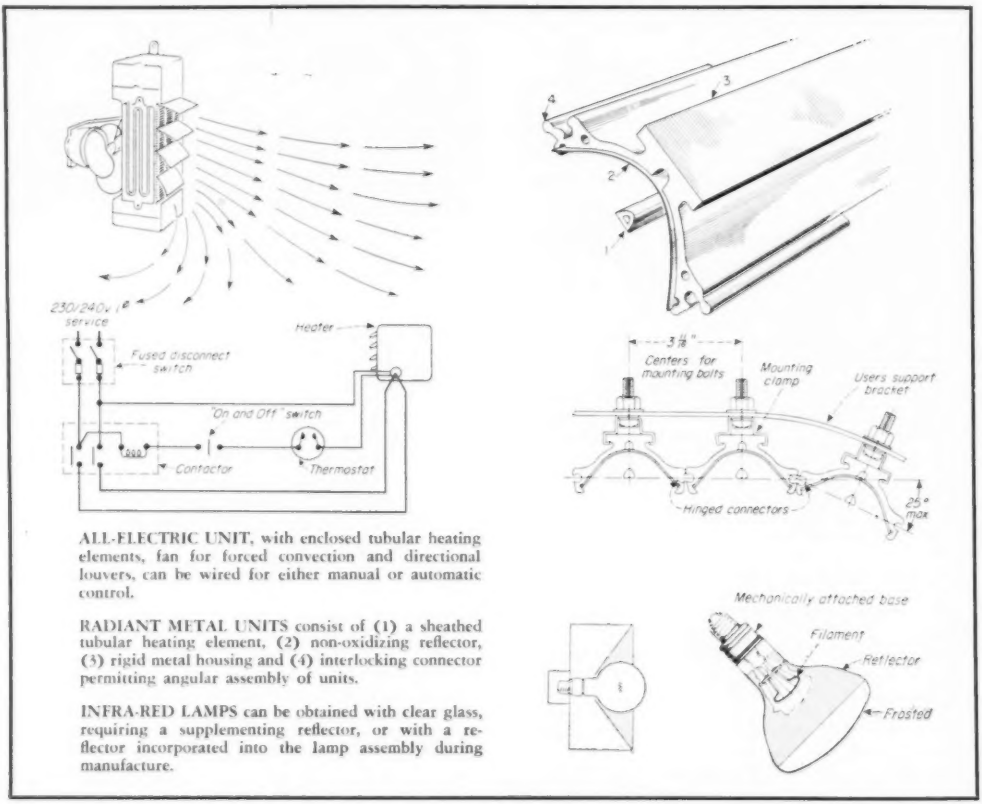
USES for electric heat in industry are many, and advantages are equally numerous. With no open flame, combustion gasses are absent. With heat concentrated at the actual point of use, temperature of the surrounding air is lower and heat losses are restricted. Controls and protective devices are positive, safeguarding operator, equipment and product. Heating units are relatively compact and light in weight, simplifying installation and maintenance.

Two factors contribute to heater efficiency: selection and application. Selection is governed by the purpose for which the heater is required, by the physical characteristics of the material being heated, and by the available space and desired heat range. Application depends to a large degree upon the methods employed to reduce heat losses through convection, conduction and radiation; upon the proximity of the heat to the objective; and upon the efficiency of insulation. Due to these factors, convection heating is recommended for ovens, kilns and confined space; conduction heating is ideal for irons, molds and hot plates; and immersion heaters are advantageous for oil storage tanks, sterilizers and water stills.

In selecting the heat source best fitted for a specific application, contractors, engineers and maintenance men have a wide field of choice, for available sources include enclosed heating elements (strip, ring, disc, tubular and cartridge), self-contained unit space heaters, radiant units employing infra-red filament lamps and tempered glass, heating cable and high-frequency or "radiothermic" units (induction and dielectric).

UNIT HEATERS

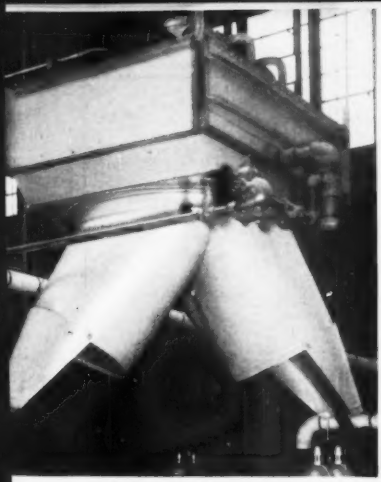
Self-contained all-electric unit space heaters consist of a housing enclosing either exposed or enclosed heating elements. Exposed elements can be glowing high-temperature coils or "black" low-temperature wires.



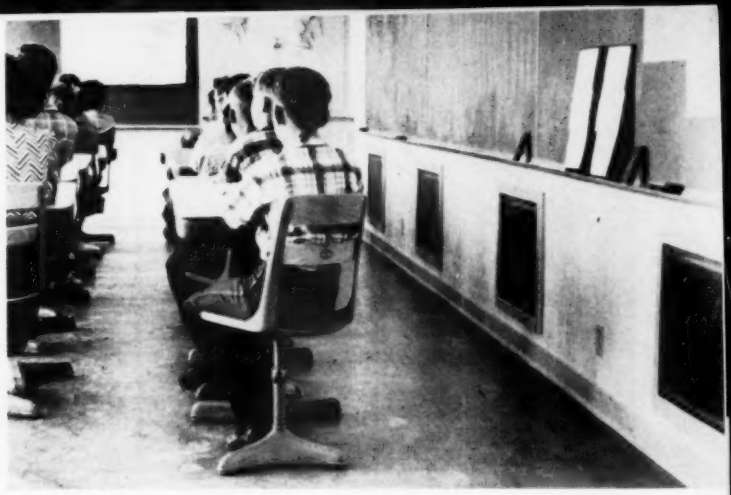
ALL-ELECTRIC UNIT, with enclosed tubular heating elements, fan for forced convection and directional louvers, can be wired for either manual or automatic control.

RADIANT METAL UNITS consist of (1) a sheathed tubular heating element, (2) non-oxidizing reflector, (3) rigid metal housing and (4) interlocking connector permitting angular assembly of units.

INFRA-RED LAMPS can be obtained with clear glass, requiring a supplementing reflector, or with a reflector incorporated into the lamp assembly during manufacture.



FAN HOUSING, forcing air over steam coils and through directional funnels, can be installed to efficiently circulate heat.



RECESSED PANELS can be located in walls, beneath windows or school chalk boards, or in ceilings. Floor space is conserved, heating is even and readily controlled, appearance and safety are excellent.

Enclosed heating elements (strip or tubular) may or may not be fitted with fins or grills for faster heat dissipation. Radiant heating elements may also be incorporated in the units. Heaters supplying warmth by natural convection may or may not have reflectors, and units utilizing fan-forced convection may or may not have directional vanes, deflectors or diffusers. Where steam or hot water lines are available for radiator connections, heating units utilizing these utilities can be obtained, with electric fans and thermostatic control. A variety of mounting brackets, pedestals and hangers adapt the units to a wide range of space-heating applications and installation conditions.

INFRA-RED LAMPS

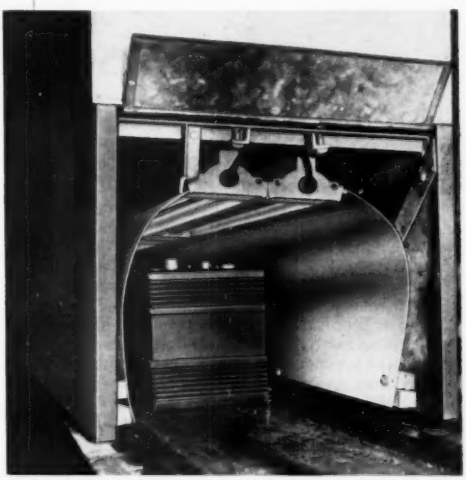
Radiant energy from *infra-red* filament lamps is well suited for industrial purposes, inasmuch as this energy travels through air and water vapors with only slight absorption, yet penetrates most solids in the path of the rays. This characteristic makes infra-red energy ideal for baking (curing), heating (causing physical changes) and drying (evaporation). The most common industrial application is for curing finishes, such as enamels (cured primarily by polymerization), varnishes (through oxidation) and lacquers (evaporation).

Infra-red energy is also widely used to vaporize solvents or moisture from various materials and products; evaporation speeded by increasing the circulation of air, raising temperatures and keeping humidity down.

Infra-red heat is constantly growing in popularity because of its speed, uniformity, efficiency, low initial and operating costs, flexibility, compactness, safety and ease of installation. Lamps can be used singly or in groups, on movable frames or bases for local heating, or permanently installed in ovens or tunnels designed for specific operations.

ALL-METAL RADIANT UNITS

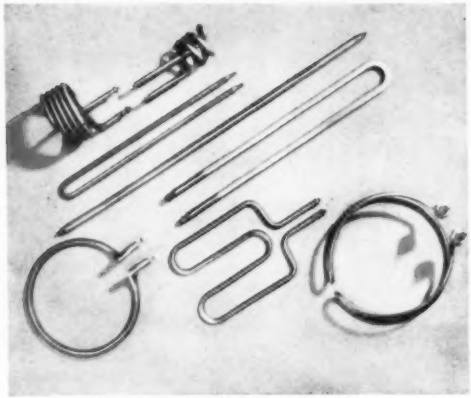
Where glass lamps are not feasible or desirable from a breakage standpoint, infra-red heat can be provided by heavy-duty rugged and unbreakable alloy-sheathed *tubular radiant heating units*, constructed to withstand moisture, dust, shock and vibration. With parabolic reflectors only a few inches deep, the units can be installed in restricted spaces. And, with adjacent assemblies connected by tongue-and-groove hinge-acting joints permitting rotation up to 25 degrees, the heating elements can be fastened together to form banks, ovens and tunnels, conforming to the shapes of products carried by conveyor chains or belts.



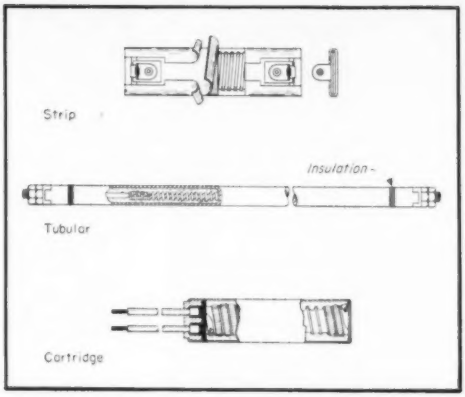
RADIANT HEAT is widely used for continuous-flow conveyor-belt operations where speed, thorough heating or drying, safety and exact control are desired features.

Wiring consists of circuit connections to the two ends of the element, and heat output can be varied from 4- to 100-percent through rheostat controls.

Another type of radiant heat (primarily designed for residential and commercial use) may be obtained from panels. One type consists of *tempered glass*, into which is permanently fused chemical heating elements radiating infra-red rays when panels are in operation. Another type utilizes *conductive rubber* sealed between layers of phenolic impregnated insulation and backed by aluminum foil.



TUBULAR ELEMENTS can be straight, or formed into any desired shape for variety of applications. Sheath temperatures and sheath materials are designed for range of applications.



ENCLOSED HEATING ELEMENTS include strip, tubular and cartridge units. Sectional views show resistance coils, compacted refractory material, insulation, and metal sheaths.

Encased Elements

STRIP heaters of either flat or curved rigid construction consist of nickel-chromium resistance wire or ribbon encased by heavy sheet or chrome steel, monel or rust-resisting iron sheaths. Insulation between resistance coils and exterior casings is generally magnesium oxide powder, while cores consist of a ceramic, mica or similar formation. High thermal conductivity within the heating strip is obtained by subjecting the assembled unit to heavy pressure during manufacture.

Since connection terminals can be placed on the same or on opposite ends of the strips, wiring can be varied to meet local arrangements—with connection possibilities including braided asbestos fiber, flexible nickel cable and special busbars punched to fit over strip terminals.

Constructed as straight units or with a lengthwise or cross-sectional curvature, strips may be clamped tightly against flat or rounded surfaces. They may also be used as air heaters, or immersed in liquids, although this latter application is not common.

Having the advantages of low cost, ease of installation, uniformity of strength and heat emission, long life and permissible variations in size and shape, strip heaters are suitable to many applications—a few of the more common uses being drying ovens and cabinets, babbitt and solder pots, grease vats, hot plates, oil storage tanks, water baths, presses and process machinery.

Ring and disc heaters approximate the construction features of strip units, with various diameters permitting the concentric nesting of units one inside another to concentrate heat in devices such as hot plates and molds. Nesting permits more than a single level of heat—a feature that can also be incorporated into a single ring having multiple internal circuits and terminals.

Tubular heaters are used for every conventional application: immersion (water, oil, paraffin, alkaline solutions, solder), conduction (clamping to, or casting into metal forms or plates), convection (baking ovens and space heating) and radiation (baking, drying, dehydrating).

Consisting of nickel-chromium resistance wire, magnesium-oxide insulation, and non-scaling corrosion-resisting casings, tubular units are compressed into a homogeneous assembly. When sealed from the air and physically protected against damage, these units are practically indestructible.

The most extensive use for tubular heating elements is for immersion—the most efficient method for heating liquids. Direct-immersion units can be hung over the side of a container; installed in a tank using a flange, gasket and pressure bolts; sweated into a threaded collar which will engage standard pipe threads; or incorporated into a circulation unit. Terminal covers for cable and conduit are available.

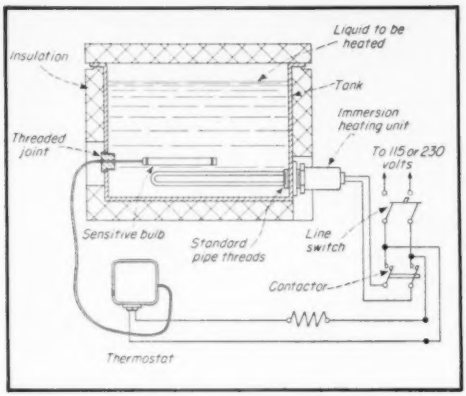
Hanging, or "over-the-side" heating elements are recommended for tanks not suited for threaded connections, such as concrete, wood or slate containers. They are also recommended when elements are shifted frequently or withdrawn for cleaning.

Explosion-proof steam radiators, recommended for Class I Group D atmospheres (vaporized petroleum products, butane, alcohol, acetane, natural gas) and Class II Groups F and G atmospheres (coal, coke, carbon black, flour, starch, grain dust), also employ immersion tubular heating elements.

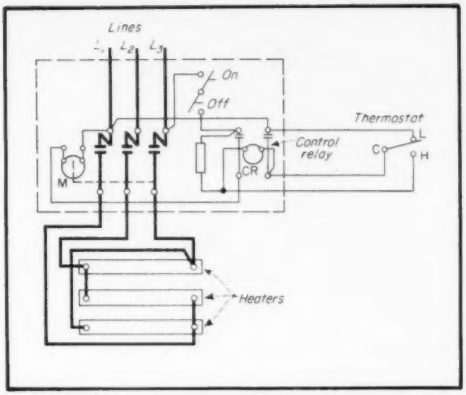
When impractical or impossible to use tubular units for immersion, they may be cast as an integral part of the metal surface to be heated, located in grooves in the surface, clamped or welded to the surface, or located in air adjacent to the surface.

Both tubular and strip heating elements are used with series of brazed fins closely spaced along the length of the elements for faster dissipation of heat into the surrounding air. Used singly or in groups, these finned units are especially suited to forced convection and are used for electric unit heaters; in air ducts, industrial hot-air blasts and recirculation ovens.

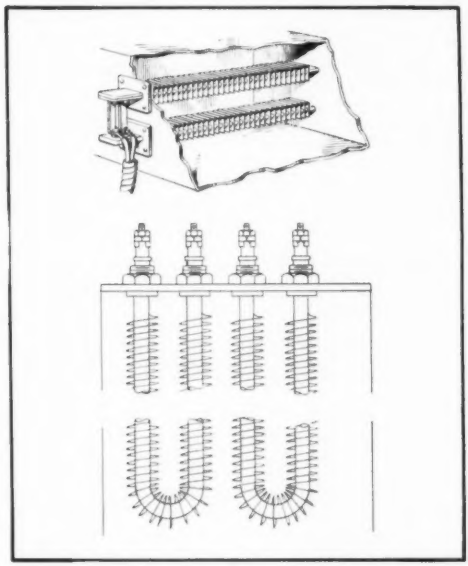
Cartridge heating elements also use the general construction principle of an isulator core, coiled nickel-



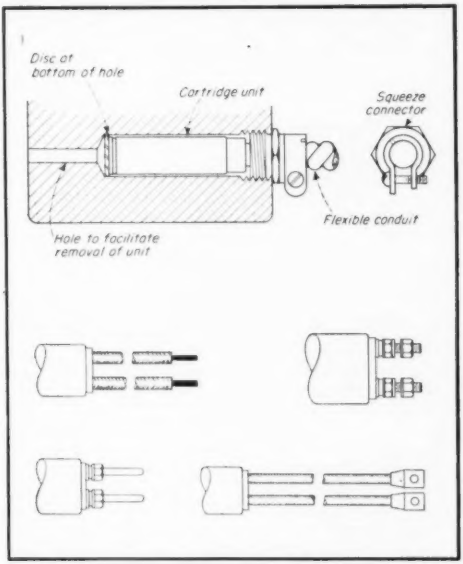
IMMERSION UNITS can be automatically controlled by thermostat and magnetic switch. Heating tubes are sweated into threaded collar that screws into standard pipe threads.



TYPICAL WIRING DIAGRAM of 3-pole magnetic contactor handling large heater load balanced on 3-phase system, with thermostat controlling contactor through relay.



FINNED STRIPS AND TUBES are used in air ducts and similar locations where forced convection directs air between elements. Finned construction rapidly dissipates heat.

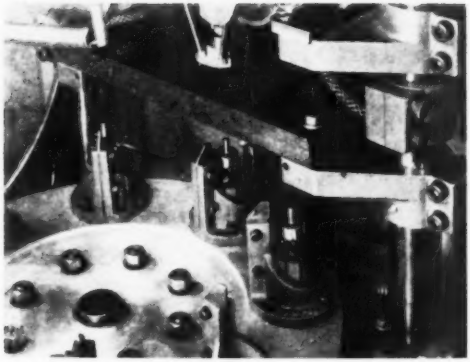


CARTRIDGE UNIT is inserted into platen with small continuous hole and end disc inserted to facilitate removal of unit. Terminals may be of the flexible, bolt, prong or clip type.

chromium alloy resistance wires, a refractory insulating material and a metal sheath. Comparing them to tubular elements, they are larger in diameter, shorter, and of rigid, straight formation. Depending upon application and desired sheath temperatures, casings can be of copper, brass, steel or alloy, providing a range of available temperatures from about 200- to 1200-degrees F. Terminals (flexible, prong, bolt, clip or detachable) extend from either one or both ends of the tube through ceramic blocks. After assembly, cartridges are die pressed to insure uniformity of diameter and density.

Cartridge heaters are particularly adaptable to local heating of process machinery, branding irons, molds, platens, dies and rolls. To install them, it is only necessary to drill a hole in the part to be heated, with the hole diameter equal to the listed diameter of the cartridge. Since the cartridge will expand slightly when used, the fit will be snug, insuring efficient thermal conductivity. However, since this snug fit makes it difficult to replace the cartridge, it is customary to drill a small pilot hole entirely through the part being heated; so that the heater can be driven out of the hole if necessary.

STEEL CLUTCH discs are heated to 350-degrees F (for bonding facing to discs) by means of induction generator and a 3-place work coil. Induction heating prepared 3 discs every 20 seconds.



MOTOR COMMUTATORS have 10 copper wires soldered simultaneously to the hooks every 6 seconds, by means of induction heat generator with indexing dial feed and automatic multiple solder feed.

Heating Cable

HEATING cable is finding numerous applications for heating soil and pipe lines; preventing the formation of ice or snow on roofs, sidewalks and driveways; protecting sprinkler system, valves and pumps from freezing; and heating floor slabs of barns and poultry houses. Wherever temperatures between freezing and about 165-degrees F are desired, this flexible source of heat is applicable.

Consisting of insulated resistance wire within a lead sheath, the cable can be purchased on bulk reels or obtained as pre-cut and pre-connected assemblies with the two ends brought together in an attachment plug that can be inserted into any convenience outlet. Operating voltages are generally 110-, 220- or 440-volts. The extreme flexibility of the cable permits bends with radii of a few inches, making it possible to place the cable in hairpin layouts and build up the heating intensity to any desired level.

Control is either manual or automatic; the latter method utilizing thermostats buried directly in the soil being heated or strapped to the pipe or piece of apparatus requiring warmth. With thermostats in close contact, accuracy of control and conservation of energy is obtained.

Heating cable, when installed to prevent pipe lines from freezing or dropping below minimum temperatures, can be run parallel to the pipe (fastened by pipe straps similar to those used to hold insulation in place) or wrapped spirally around the pipe. For most efficient operation, pipes are also insulated, confining the heat in the enclosure and protecting the cable from mechanical injury. Insulation is removed only from the section occupied by the thermostat, so that the calibrated dial is visible.

To prevent ice from forming on roofs, cable is installed along the eaves in a triangular pattern, with the peaks of the triangles several inches higher than the intersection line of the roof and vertical house walls. Cable can be attached by means of copper straps fitted with rubber grommets. Roofing compound is recommended to prevent leaks from developing around the nails. To safeguard the installation, the metal gutter and downspout should be grounded as indicated in the sketch on the opposite page.

A new heating term, coming into being during the past decade, is "radiothermics", that is, heating by means of high (radio frequency) electric currents. Fundamentally, the difference between high-frequency and conventional heating lies in the fact that h.f. current generates heat *within* the material being heated, whereas conventional heating (convection, conduction, radiation, immersion) must penetrate the material from the *outside*.

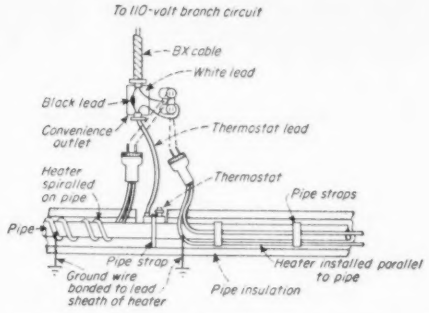
INDUCTION HEATING

Probably the greatest strides in heat treating and brazing metals recently have been taken in the field of induction heating. Simply stated, induction heating utilizes the principle of the transformer. The workpiece, which must be an electrical conductor, is surrounded by a conducting coil, forming the primary that carries ac with frequencies up to 5 megacycles—a megacycle equalling a million pulsations a second. The workpiece forms the transformer secondary, and the induced current is converted into heat energy through the resistance of the metal.

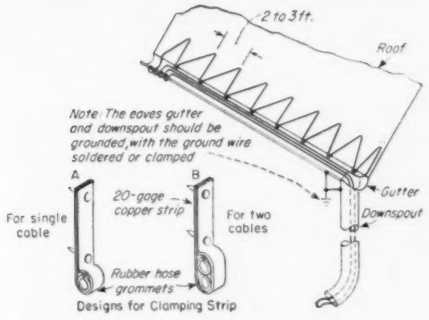
Since ac tends to hug the surface of a conductor, the higher the frequency is the more closely the current remains on the surface. Using this theory, it is possible to control the penetration of heat by regulating the frequency of the current.

Commercial production of high-frequency ac can be obtained by motor-generators, vacuum-tube oscillators, mercury-arc and spark-gap converters. Utility power in the 25-60-cycle range can also be used for some induction heating jobs, such as relieving annealing stresses or heating vats. The other mentioned methods are recommended for various applications in the fields of melting, forging, hardening (both case and through), brazing and sintering.

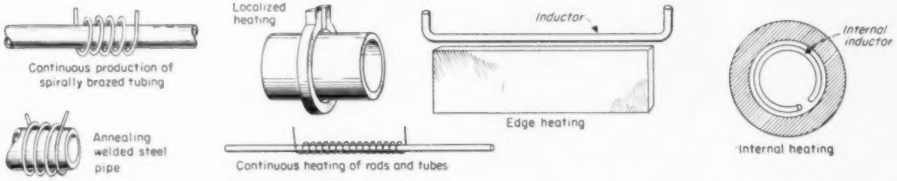
Each method has both advantages and disadvantages, specifically fitting them for some jobs and barring them from others. For example, m-g sets are available for both small and large energy requirements, but frequencies are limited by mechanical design, efficiencies are relatively low and maintenance problems are present. Vacuum tube oscillators are fixed-frequency generators providing current up to 5 mc. They



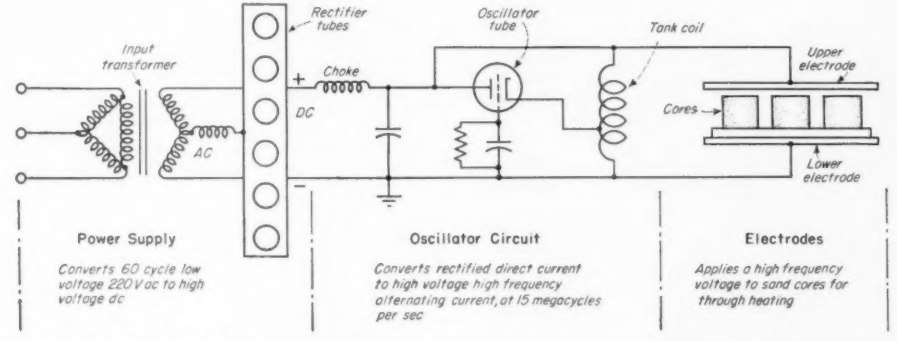
HEATING CABLE can be installed parallel to, or wound spirally around, pipe lines. Heat is confined by pipe insulation and controlled by means of a thermostat clamped directly to the pipe being heated.



ROOF INSTALLATION of heating cable consists of triangular arrangement, held in position by copper strips fitted with rubber grommets. Gutter and downspout are grounded in accordance with sketch.



HIGH FREQUENCY COILS can be placed around or inside variety of products, with penetration regulated by means of production cycle and current frequency.



DIELECTRIC BAKING of cores cuts heating cycle from 4 hours to 2 minutes. Alternating current at 60 cycles and 220 volts is converted to high voltage dc, then to high voltage high frequency, ac.

are relatively small per kw capacity and have long lives (up to 15,000 hours). One disadvantage, however, is the necessity for water cooling. Spark-gap circuits are limited to about 200 kilocycles and 20 kilowatts. They are simple units but have limited outputs and several maintenance disadvantages. For these reasons, careful comparison and selection of units is imperative for economical utilization.

Production line brazing and soldering operations are ideally suited to induction heating. By causing heat to be transferred to solder or a brazing material from the parts to be joined, rather than vice versa, complete wetting of the hot metal by the solder results, and joints are stronger, tighter, more uniform as a result.

Dielectric heating fundamentally consists of holding a *non-conducting* workpiece (such as rubber, wood or ceramics) between two plate electrodes, in a high frequency (over 1-million cycles) circuit. The resultant molecular oscillations in the substance cause internal friction which causes uniform internal heating. Uniform heating in every section of the material, the center as well as the surface, is particularly important in drying, sterilization and heating for physical changes. With this fast, uniform heat, temperatures for baking or curing are reached in a matter of seconds or minutes rather than in hours.

NEW FRONTIERS

Higher lighting levels with improved quality and increased seeing comfort are on the horizon. Present high standards and technological knowledge are paving then ever and point to continuing in-then ever, and point to continuing increases in annual sales for years ahead.

Lighting Development

HISTORICALLY, electric lighting has been in use less than three-fourths of a century. But its growth and technological development have been phenomenal. The lighting industry has boosted its volume to near a billion dollars annually for lamps and lighting equipment. In addition, electric power used for lighting purposes in 1950 was estimated at over $1.6-billion more, and wiring for lighting now totals over a billion dollars a year.

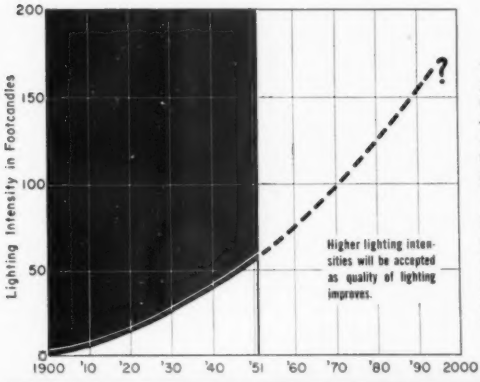
Major lighting progress has been made during the last 17 years, since the introduction of higher efficiency electronic-type light sources—high intensity mercury vapor in 1934 and fluorescent in 1938. From 1879, when Edison made the first incandescent electric lamp, until 1934, the incandescent filament lamp was the principal light source. During these years lighting progress was slow but sure, following developments and improvements in light output efficiency rather closely. Fundamentals of good artificial lighting, however, were fairly well established during this period, and the basic rules for control and application of lighting were set up. Development of new and better light sources, and of new materials for control and equipment, have made possible full utilization of the basic knowledge gained through these years of research and practical experience.

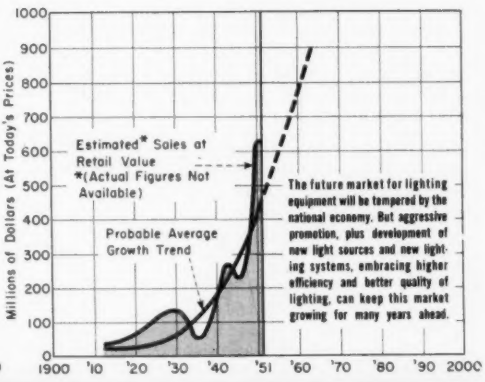
The importance of research in lighting development cannot be overstressed. It has been responsible for the continued development of new and more efficient light sources. It has resulted in new and improved types of equipment for outstanding development of application techniques.

Light output efficiency of the filament lamp in use in 1900 was about 5 lumens per watt. Its efficiency was raised to about 20 l/w. by 1934, when the 400-watt mercury vapor lamp with 40 l/w. was brought out. In 1938 the fluorescent lamp was announced, producing about 50 l/w. The fluorescent slimline lamps were next made available in 1944, with an efficiency of about 60 l/w. Improvements in design and production techniques have resulted in still higher efficiencies for some size lamps; so that now 65 l/w. are available for lighting application.

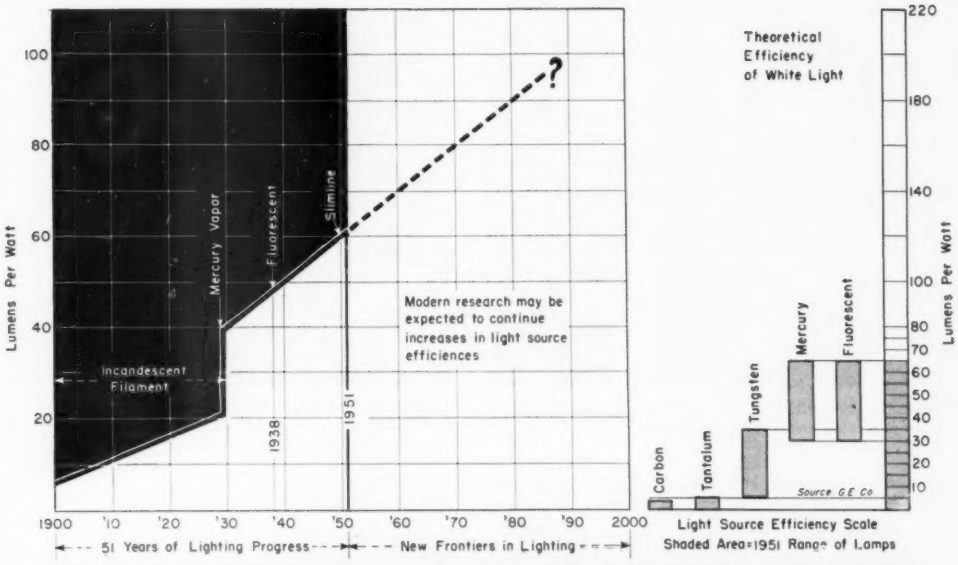
The story of lighting equipment growth and development is full of romance and interest. It began with the use of open reflectors supported on drop cords. Then

IN LIGHTING




Millions of Dollars (At Today's Prices)
1000
900
800
700
600
500
400
300
200
100
0
1900 '10 '20 '30 '40 '51 '60 '70 '80 '90 2000
Estimated* Sales at Retail Value
*(Actual Figures Not Available)
Probable Average Growth Trend
The future market for lighting equipment will be tempered by the national economy. But aggressive promotion, plus development of new light sources and new lighting systems, embracing higher efficiency and better quality of lighting, can keep this market growing for many years ahead.

GROWTH OF ACCEPTED STANDARDS FOR GENERAL LIGHTING — GROWTH OF LIGHTING EQUIPMENT SALES—ALL TYPES



LIGHT SOURCE EFFICIENCY GROWTH FIRST HALF OF 20TH CENTURY

later, as lamps became brighter, diffusing globes replaced the open reflectors. Indirect lighting was accidentally discovered in 1908, and by the 1930s, had become an important standard for general lighting. Artificial skylights were also developed, eventually leading to trans-illuminated ceiling or side wall elements. Highly ornate luminaires, lanterns, brackets, chandeliers, etc., were the vogue for many years. Because filament lamps were point sources of light and could be accurately controlled, the trend of recessed units eventually evolved.

Then with the introduction of fluorescent lamps, a linear light source, new techniques in design became necessary. Functionalism in lighting began to make progress and influenced lighting equipment design and application. The result has been the rapid development, during the past ten or more years, of new concepts of lighting application.

Lighting Progress

TODAY lighting progress is truly on the march. The lighting industry, at this century midpoint, has reached a new level of technological and esthetic knowledge in its art and profession. Architects, engineers, and lighting application men now have more and better lighting tools—light sources, luminaires, lighting components—with which to work. They also have new knowledge and a better appreciation of the influence of color, of brightness ratios, and of spectral quality of light itself in lighting applications.

Much of this progress has been made over the past 10 to 15 years, and especially post-War II. The fundamentals had been learned over the past half century—principally through research and practical experience. It has been the application of the sound principles of lighting, based on these fundamentals, which has spurred on progress at an ever-increasing rate.

The field of illuminating engineering as an art has of necessity been widely expanded. Selection of light sources and of lighting equipment to produce a specified lighting intensity is no longer considered an adequate solution for a lighting problem. The final lighting result also depends on the skillful application of other technical and artistic considerations.

Illuminating engineers have now recognized the need for more quality in the lighting result. They have also recognized the need for consideration of other features in lighting systems, including: 1) appropriateness of lighting system design features to harmonize with architectural design; 2) proper reflectances of all surfaces within an interior to provide comfortable brightness ratios; 3) elimination of all fatiguing direct and reflected glare; 4) conformity of lighting design and color quality of the light itself with interior color and decorative treatment;

RECESSED INCANDESCENT units combined with fluorescent lighting in coves, wall and floor cases for selling.

DECORATIVE LIGHTING effects with ample light for seeing are requisites for a cheerful lighting result in restaurants.

DIFFUSE LIGHT from large area fluorescent units is well suited to many display areas, such as auto showrooms.

LOW BRIGHTNESS TROFFERS provide high intensity glareless lighting of good quality for office areas, large and small.

MERCURY VAPOR LIGHTING with 400, 1000, or 3000-watt units is effective for large manufacturing areas.

HIGH LEVEL general lighting intensities are provided by continuous row fluorescent units on close spacings.

5) proper evaluation of highlights, shadows, diffusion and combinations thereof, and other psychological and physiological considerations.

On the technical side, illuminating engineers have now recognized the need for other refinements in lighting design, including: 1) functionalism in lighting; 2) selection of the light source, or combination of light sources, which will most effectively and most efficiently produce the desired lighting result; 3) selection of economical system circuit voltages, especially for gaseous discharge-type light sources; 4) economical wiring circuit design; and 5) multiple switching and control of lighting systems to provide maximum lighting flexibility and user benefits.

Many lighting men have for several years recognized the importance of expanding the field of illuminating engineering to embrace these related considerations. Some of them have pioneered in this practice. But now, illuminating engineers generally are accepting this broader responsibility in lighting application design. It is in these and related fields that the art of lighting has forged ahead at an accelerated pace in recent years.

The field of lighting is also expanding in scope. Artificial light is being used for more and more types of application. It is now being used in such fields as crime detection, photography, horticulture, luminous decoration, and in nearly every branch of commerce and industry.

The field of lighting for seeing is of course of major interest to most illuminating engineers, architects, interior decorators, and others concerned with the lighting of industrial, commercial and institutional buildings, homes, and places of amusement and recreation. This is the field with which this discussion is principally concerned.

Shown on these pages are several pictures which illustrate current modern lighting practice. These pictures also cover a wide range of applications and of current lighting techniques. Each has been carefully selected from nearly 400 pictures submitted by lighting equipment manufacturers and electric utility company lighting engineers. These have been captioned to show some phase of lighting progress. Obviously the list is incomplete. But an analysis of the techniques shown, and of the following comments on progress in some of the major fields of lighting application, will aid in an appraisal of lighting progress to date.

Industrial Lighting—The need for around-the-clock operation of industrial plants during World War II resulted in a new appraisal of industrial lighting requirements and methods of application. Also, the lighting industry had a new light source, the fluorescent lamp, which offered new high efficiencies and a new approach to general lighting solutions. High intensity mercury vapor lamps were also relatively new, especially the 3,000-watt, 120,000-lumen lamp, and ready for further experimental application. Higher intensities were demanded by need for increased production and decreased spoilage of critical materials. This demand for higher illumination intensities and for longer hours of use, and the availability of new higher efficiencies in light output, was boldly met by the lighting industry. Accepted levels for general lighting rose rapidly from 20-30 footcandles to 40-60 footcandles. Many installations of 75-100 footcandles were actually installed.

COMBINATION MERCURY-INCANDESCENT lighting is used in most heavy metal-working industries. High reflectance ceilings and side walls are also important.

Currently refinements in industrial lighting are getting more attention. Better brightness ratios between the visual task and the surround are being studied for production areas. Many manufacturers have already designed better shielding against glare

INDIRECT LIGHTING from bowl-silvered lamps in attractive shielded pendant luminaires, still finds application in many areas, as in this school classroom.

LOUVERALL CEILING provides high level lighting over work area, and cove lighting creates cheerful atmosphere in public area of modern bank.

from reflector units. Open top reflectors are being advocated by some lighting engineers, and one manufacturer is now making a luminous (plastic) side reflector to allow ceilings in industrial plants to be softly illuminated.

In addition to providing higher levels of general illumination in industrial plants, many lighting engineers are putting new emphasis on supplementary or local lighting at the point of work. General lighting levels of 75-100 footcandles, with local levels of 150-200 footcandles, are not unusual today, and the general trend is in this direction.

Commercial Lighting—Use of practically the entire range of lighting knowledge is now being made in the field of commercial lighting. In offices, the goal is high levels of well diffused light to provide the maximum comfort and ease for seeing. In stores, the goal is to use light for attraction, for decorative purposes, and for critical and accurate appraisal. In other types of interiors—hotels, theatres, restaurants, night clubs, ball rooms and banquet halls, etc.—more emphasis is being placed on adequacy of light for easier seeing where seeing is important, and the use of light as part of the decorative treatment.

Progress in office lighting is featured by better quality and higher levels. Lighting engineers stress higher reflectance values for all surfaces in the field of view.

Department and specialty stores of all types are now capitalizing on the value of light to help them sell their goods. General lighting levels are being upped. Special displays are being highlighted. Better spectral quality of artificial light is being demanded by store owners to permit more critical appraisal of the merchandise. Lighting engineers can now provide just the right spectral quality of light to meet these specific lighting needs. And in using light for decorative purposes, architects and designers are continually finding new and unique methods of application.

The lighting of hotels, restaurants, theatres, night clubs, etc. are all specialized fields. In general, the lighting problem is two-fold: provide a good quality and quantity of light for purposes of seeing, and use light as part of the decorative medium.

Institutional Lighting—Progress in institutional lighting has been principally that of better diffusion, higher intensities, conformity of lighting elements with architectural or decorative details, and improved methods of obtaining directional control for those areas where needed.

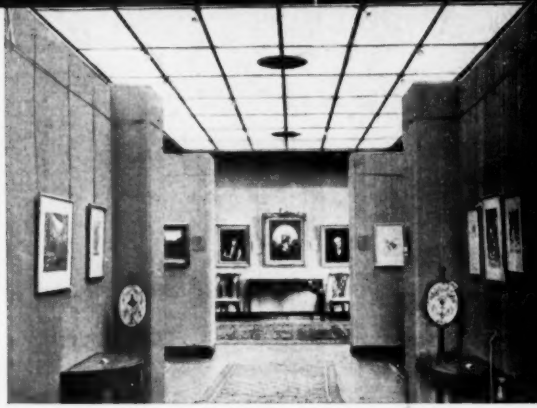
In institutional lighting, the most outstanding progress undoubtedly has been in school lighting. Standards for both artificial and daylight lighting have been established, covering both lighting intensities and brightness ratios. In actual practice, many schools are greatly exceeding the standards.

Many outstanding lighting installations have also been made in libraries, banks, and art museums recently. In nearly all cases, high levels of well diffused light, free from direct or reflected glare, have been provided. A broad range of lighting techniques have been used, reflecting the lighting engineers' technical knowledge and the architects' design ability, and combining modern lighting techniques with architectural details, both functionally and effectively.

Hospital lighting has progressed slowly. Few changes have been made in operating room lighting over the past 15 years. Attempts at solving ward lighting problems have been made, some with fair success; but much remains to be done in this field.

Residential Lighting—Residential lighting progress has been slow. Many manufacturers of home lighting equipment are still making and selling units which should have been obsoleted 15 to 20 years ago. Some producers have recognized the need for functional home lighting and have made available some few units to meet these needs. These include; better kitchen lighting units, reflector units for undercabinet lighting, valance lighting, strip lighting for coves and recesses, direct-indirect floor and table lamps, new bed lighting units, illuminated house numbers, mirror lighting for the bath and dressing

FLUORESCENT TROFFERS in geometric pattern, surface installed, with incandescent lamps in corner sections, provide efficient general lighting in a modern library.



LUMINOUS CEILING provides shadowless general lighting in a college museum. Reflector spot lamps light sculpture and highlight paintings.

room, and recessed downlights for living rooms, dining rooms and similar areas. But in the main, much research and development of new designs and new home lighting techniques are needed to solve the many lighting problems still existing in the home lighting field.

Decorative Lighting—Light is now being used extensively as a decorative medium. Architects and designers, with the proper appreciation of the use of light in architectural design, are achieving unusual decorative treatment for all types of interiors.

Light patterns in design treatments are possible in any desired color. Light sources are available in a wide range of colors, and lighted surfaces or translucent media can also be of almost any color selected.

More and more attention is being given to the subject of color in lighting.

Little use is being made today of artistic lighting units and luminous ornaments. The industry has the know-how to do more in this field.

Outdoor Lighting—In general, outdoor lighting has kept pace with interior lighting. This is another highly specialized field. In it, not only is light control important, but also the problem of making units weatherproof has had to be considered.

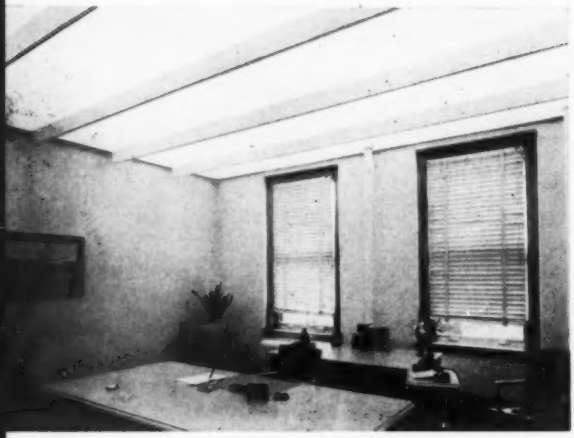
In street and highway lighting, incandescent light sources are still used predominantly. But mercury vapor units are proving to be both practical and popular, and some few fluorescent lighting installations have been made, mostly experimentally.

Airport lighting has paced technological knowledge, because of its importance for safety. Progress has been principally in the field of runway landing lights, and in application techniques as landing aids.

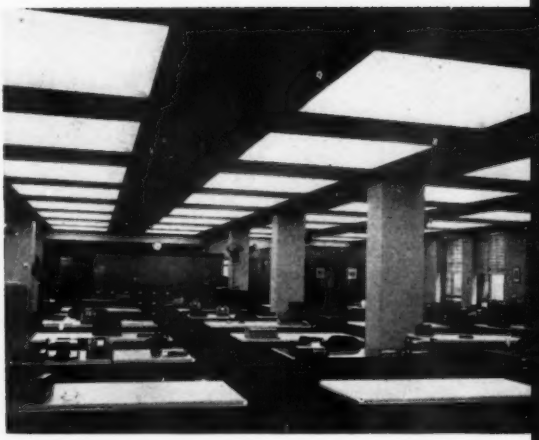
Recreational lighting has been a rapidly expanding field for the past 15 years. Professional leagues have proved money-makers, and new lighting levels for night baseball and football have been adopted. At college, high school and playground level, all types of sports areas have been lighted.

NON-GLARING HIGH LEVEL illumination is provided for modern high speed highways, using both incandescent and mercury vapor light sources in prismatic control weatherproof units on appropriate spacings and mounting heights.

TRIPLE REFLECTOR UNITS, using 3/1500-watt lamps, light this sports center to 80 footcandles average. Boxing ring is lighted to over 400 footcandles by 32/1500-watt reflectors installed on special framework.



LIGHT AND SOUND conditioning, plus careful selection of color and finishes for all surfaces, combine to provide lighting of maximum comfort and quality in this private office. Intensity is 140 footcandles, with an unusual degree of lighting comfort.



FLUORESCENT COFFERS are integrated with air-conditioning in this general office to provide comfortable indirect lighting. While desk tops are light finish, floor and sides of desks should also be lighter for comfort.

OPEN TOP REFLECTORS softly light the white ceiling of this metal working plant, improve lighting quality. Machines are painted light blue for added seeing comfort.

PLASTIC REFLECTORS provide some light to ceiling in this plant by means of luminous sides, improve seeing conditions by reducing glare.

The Future

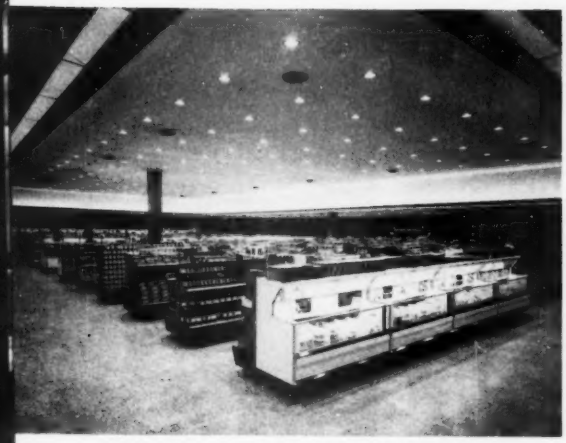
THIS nation has accepted artificial light as a necessity more and more in recent years. This is also true in many other nations. Offices, stores, factories, homes, and nearly all places where people congregate indoors, now use artificial light both day and night. There is a big demand for lighting, and that demand is growing. Also, there is a demand for an ever-increasing amount of light and for refinements in both quality and principles of application.

The future of lighting depends essentially on four factors: 1) the market; 2) promotion; 3) research and development; and 4) trends. Analysis of these factors, and of what can be done to intelligently influence each, will indicate where lighting progress should be headed. What is actually done about each factor will of course affect the future of lighting.

The Lighting Market

The ability of the American people to consume goods and services seems to be unlimited. Certainly there seems to be no saturation point on the horizon in the market for lamps and lighting equipment. This market, dollarwise, is now approximately $1-billion annually and is increasing from year to year. It is reasonable to assume that the market growth curve may eventually taper off on some normal plateau considerably higher. Best available estimates, however, show the normal lighting market growth curve doubling every 9 to 10 years. If it is assumed that this is a "normal" growth, the total volume in 1960 should be approximately $2-billion for lamps and lighting equipment. Any faster rate of increase would then represent a better-than-average market. Likewise a decrease from this normal growth would represent a set-back in lighting sales.

The lighting market is dependent principally upon two fields of activity—new building construction and



RECESSED INCANDESCENT REFLECTORS light this supermarket with 65 footcandles of quality lighting. Fluorescent lamps are used in cases and for decoration. Current trend in such areas is away from bare fluorescent lamp units.

DRAMATIC LIGHTING in display area is achieved with incandescent downlights, supplemented with fluorescent in wall and showcases. Cove-lighted ceiling provides comfortable ceiling brightness. Troffers light rear office area.

# of Lighting

modernization. The ratio between these two fluctuates from year to year, depending on the state of the national economy. However, most lighting men agree that the big market lies in modernization, or relighting. The potential for relighting alone has been estimated to be in the order of some $12-$15 billion, if all existing business and industrial establishments were relighted in accordance with current good lighting practice. This alone represents a 10-year market potential based on the present normal growth rate.

Lighting Promotion

Like any other business, the lighting market must be actively and continuously promoted, year in and year out, if its potential is to be realized. This must be done on an industry-wide basis to be fully effective. It must be done by every segment of the industry and by the full manpower of each segment.

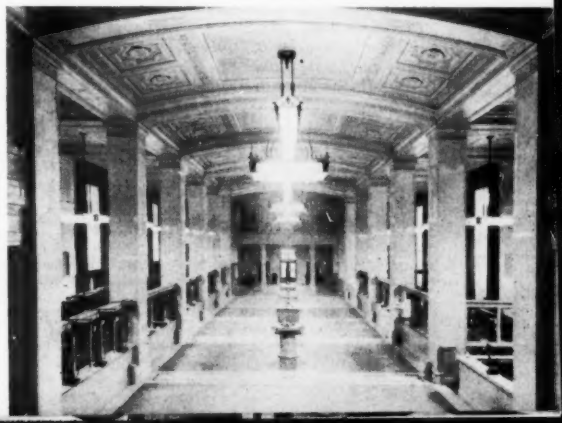
The Planned Lighting Program was the first, and is to date the only, lighting promotion activity to be sponsored by the entire lighting industry. And some segments of the industry have failed to give this program full and effective backing. But whatever the program, some promotion should be actively continued.

Lighting Research

It is difficult to determine whether research and increased technical knowledge create lighting sales, or whether increased lighting sales are responsible for greater research and development. They seem to go hand in hand. But regardless of what comes first, or which supports the other, continued active research and development—in light sources, in lighting equipment and components, and in application design—must be continued. Only through such work can lighting progress be made. Technological advances in all other fields make this highly important. The lighting

PERIMETER LIGHTING from asymmetric louvered troffers puts light on walls in this Museum. Low brightness ceiling adds general lighting, maintains ideal brightness ratios.

CUSTOM LUMINAIRES, using fluorescent lamps, were selected to relight this bank interior. Traditional interiors need better designed units of this type for such application.



VALANCE LIGHTING is supplemented by local lighting from period design table lamps in this living room. Illuminated draperies provide good background for viewing television, create a cheerful atmosphere.

LIGHTING ELEMENTS in observation lounge of *S. S. Independence* include cove, valance, recessed downlights and reflector-

industry inevitably must keep pace with all other fields of technical progress.

Lighting Trends

What are the *New Frontiers in Lighting?* What are some of the lighting developments to be expected in the years ahead? In what directions and fields of activities should the lighting industry aim its best efforts now and in the future? After a careful analysis of the lighting industry's history to date, of its past aims and objectives, and of the present state of progress in lighting technology and application, the following comments and predictions on lighting trends appear to be sound and justifiable. Many of these have come direct from some of the key men and specialists in the lighting industry.

Light Sources—Increase in light source efficiencies is an ever-continuing process. Present trends are to lower brightnesses in fluorescent lamps, may eventually lead to much larger sizes, in a limited number of modular shapes, suitable for use as luminous elements. The spectral quality of light produced by fluorescent and mercury lamps will continue to be improved. Use of incandescent lamps will continue to increase, following gradual but sure improvements. One new light source (Electro-Luminescence) is already on the horizon, and others are sure to follow.

Auxiliaries—Present troublesome auxiliary control devices for fluorescent lamps will be greatly simplified, may eventually be completely eliminated. While elimination of these devices is not now possible, public demand will spur on simplification.

Equipment Design—Design of lighting equipment and components must follow available light source sizes and shapes. Otherwise, the field of design is broad and restrained only by materials and production limitations. New designs must be such that, in general, they can be mass-produced. They will be designed to provide even more seeing comfort and higher lighting intensities. They will follow the principle of modular shapes, to provide more flexibility in application and to permit custom layouts. This is becoming more important, to meet the whims and fancies of architects, designers, lighting specialists and critical customers.

Commercial lighting equipment designs will provide more accurate control of the light and have lower surface brightness. This probably means larger units in general. Clever designers will make greater use of low brightness reflectors and new materials, probably resulting in large units with luminous side elements. Use of low brightness troffers will probably increase, in many cases may be supplemented with other luminous elements in appropriate design patterns to keep the ceiling light in appearance.

The use of luminous ceilings is now on the increase, with less acceptance of louverall ceilings. A new trend is to combine luminous panels with sound absorbing beams and panels. Use of low brightness fluorescent lamps in coffers formed by sound-absorbing baffles is also being promoted. Several recent installations feature round or square coffers, indirectly lighted with fluorescent lamps, combined with air conditioning and sprinkler systems. Use of complete ceilings of louvers or luminous panels is now being limited generally to small rooms—in large areas the trend is to large panel sections, broken up by regular ceiling sections to provide a better architectural design.

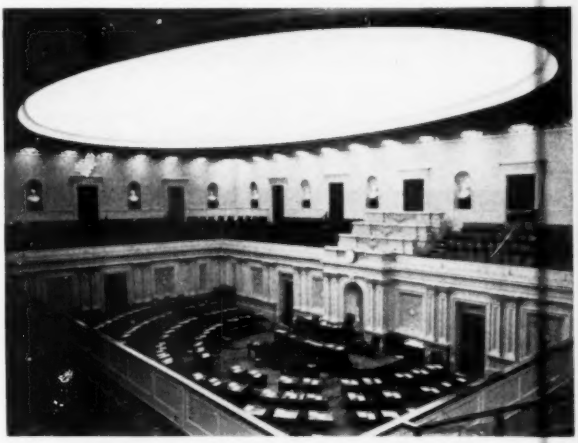
Industrial Reflectors—Changes in fluorescent industrial reflector designs are already in the making. New industrial reflectors will provide better direct shielding, will have an upward component to softly illuminate light finished ceilings, and top side of reflectors will have high reflection finishes. No radical changes in reflectors for mercury or incandescent lamps are expected.

Seeing Comfort—In all types of interior lighting, and with all types of lighting systems, more emphasis will be placed on greater seeing comfort in the future. This involves more attention to brightness ratios, better selection of colors and finishes of all surfaces in the lighted interior, such as furniture, furnishings, machines, and walls, ceilings and trim. Higher levels of illumination will also be promoted, but with even greater lighting comfort than is currently being installed with present equipment designs.

diffuser type table lamps. Flexible switching provides variety of lighting effects with incandescent lamps on dimmers.

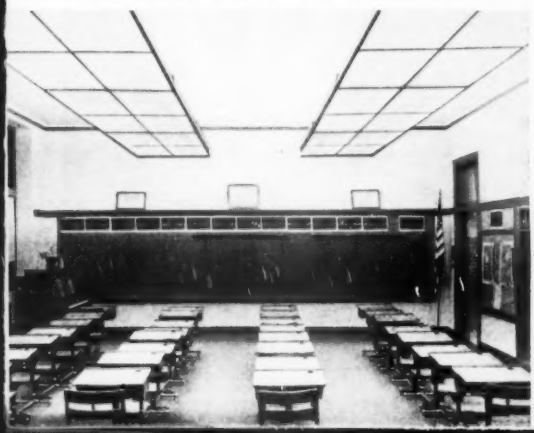
CONTINUOUS COFFERS with fluorescent lamps and recessed incandescent downlights provide flexible lighting for hall used as auditorium, dance floor, banquet hall and for other similar functions.

FLUORESCENT COFFERS combining air conditioning outlets light main reception floor of Secretariat building at United Nations headquarters, New York City.

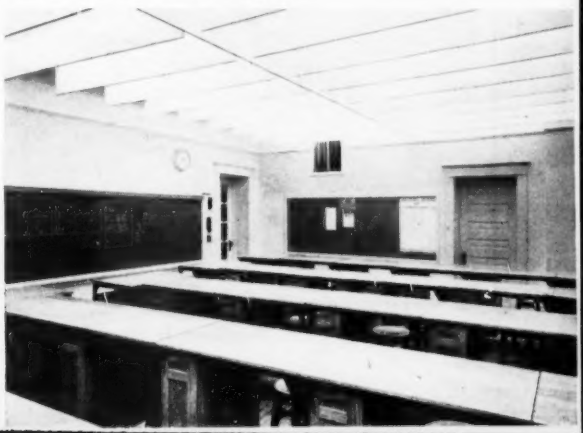


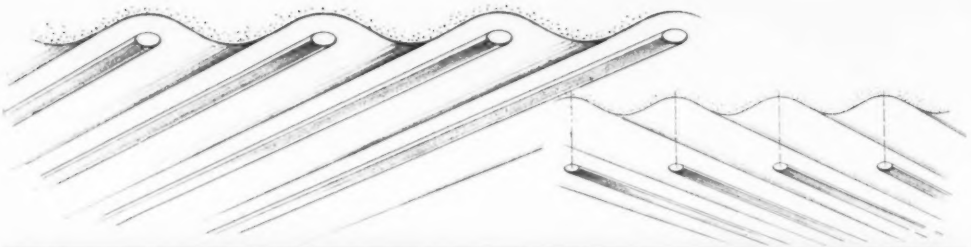
COVE LIGHTING from 200-watt incandescent lamps provides evenly lighted dome in Senate Chamber, U. S. Capitol building. Recessed units light walls and sculpture.

LARGE AREA LUMINOUS ELEMENTS provide more eye-comfort with higher intensities in a typical school classroom. Elements also light entire ceiling softly.



SLIMLINE LAMPS, shielded by 12-inch wide acoustical baffles, both on 2-foot spacing, provide 60 footcandles of comfortable light in a high school drafting room.





Suggested Application for Possible New Low Brightness Light Sources

New Lighting Ideas

NEW frontiers in lighting portend new achievements in lighting progress. These will embrace new products, new developments, improvement in existing light sources and lighting devices, greater flexibility in lighting system control, and many new lighting ideas.

Shown on these two pages are some of the new lighting ideas which current trends in lighting practice suggest. These sketches, prepared by industrial designer Ted Mehrer, represent his interpretation of some of the lighting developments predicted on the preceding four pages. Some of these ideas are practical now; others will be, as progress in light source development is made.

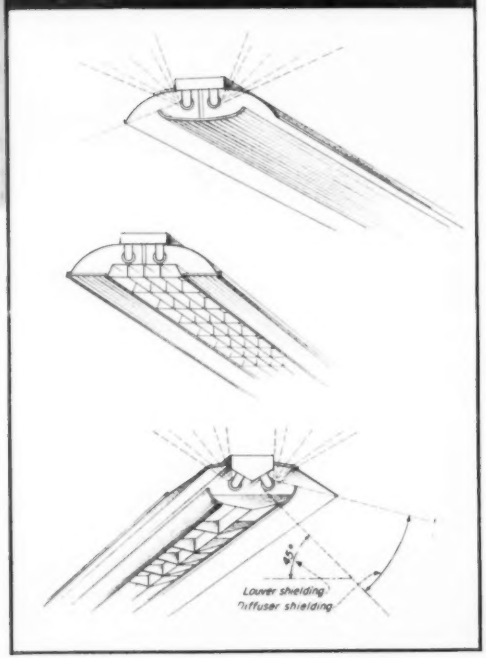
Consider new industrial reflector designs, for example. New designs are practical now, such as the three examples shown at left below. These designs permit an upward component of light, provide better shielding, and can be finished in a light color on all outside surfaces. Such designs will meet the requirements of the present trend for better brightness ratios and better shielding of lamps in industrial lighting.

Combination of two different types of lighting systems, such as is shown at top of the opposite page, is also practical now. In the examples shown, a low brightness troffer system is combined with a luminous ceiling system. This combination is used purposely for the example, since it would permit a much higher illumination level and maintain a high degree of lighting comfort. Also, from a decorative viewpoint, the luminous ceiling might be lighted in color, using any desired color of lamps in the upper reflectors to create an artistic luminous effect, while providing high level lighting in the area below with white lamps in the troffers.

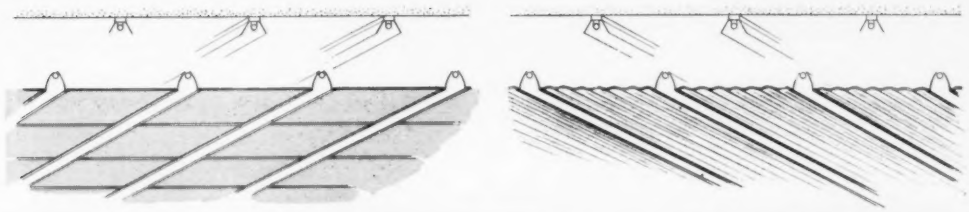
The other two illustrations are based on possible new light source developments. In lieu of such new light sources, however, luminous elements using existing light sources could also be used to achieve somewhat similar lighting treatments.

In the example sketched at the top of this page, a large low brightness light source is assumed. It could

Suggested Reflector Designs



Two Luminous Modules . . .

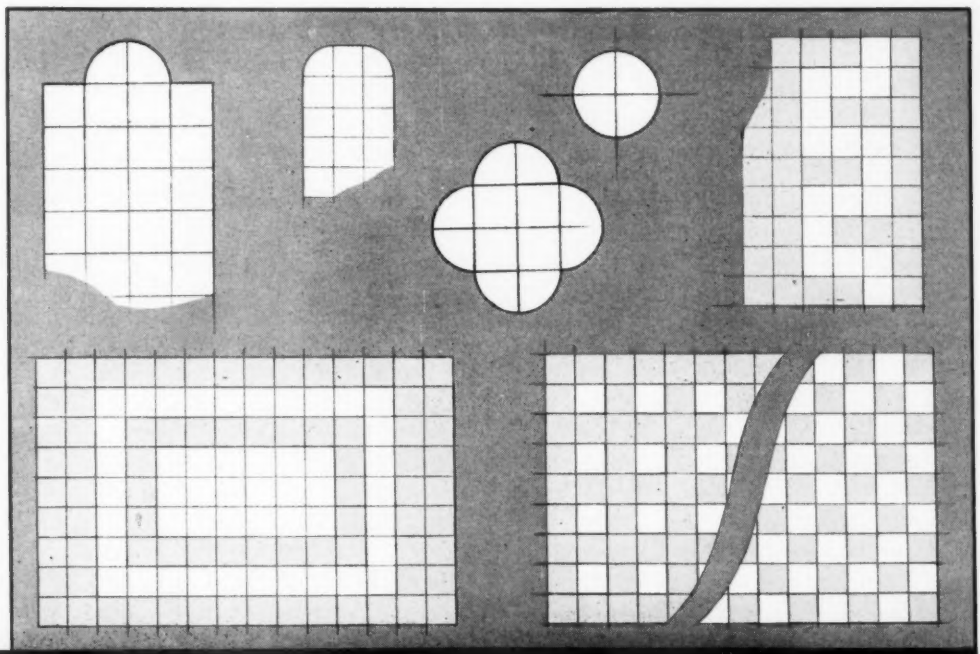


Combination Lighting Improves Quality, Adds Flexibility

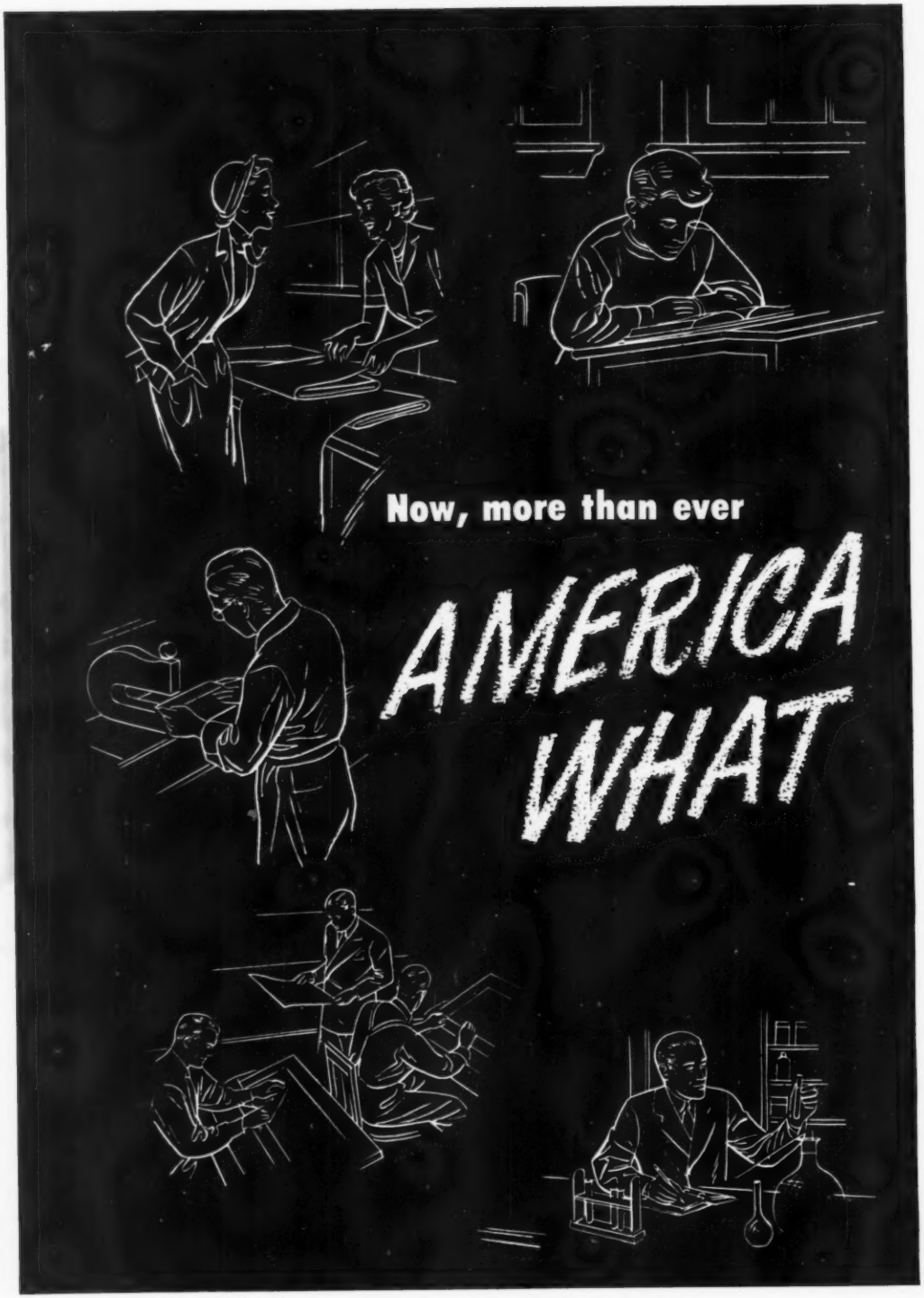
be a modular size lamp; that is, oval in cross-section and about six inches wide by two feet long. The lower half of the oval could be coated or treated for low light transmission, with the top half highly translucent. There are many possible variations in applications for such a low brightness light source. The idea derives from existing luminous indirect luminaires.

The second suggestion assumes a shallow or flat luminous element of low brightness, which could be made in modular sizes and shapes. Two modular shapes only are illustrated. These could be any convenient or practical modular size. The sketches below illustrate only a few of the possible combinations from only two such modular shapes. One new light source has very recently been announced, which fulfills the design elements shown here. It is two-dimensional, since its thickness is small enough to be ignored. It can now be made in color in low brightness, is expected to be developed in white light with higher efficiencies in the near future.

Continued progress in lighting is inevitable. The market potential is enormous, and the lighting industry is technically equipped to do a truly outstanding job. Expanding markets and technological progress go hand in hand. Before the end of this greatest of all centuries, the lighting industry will be installing undreamed-of lighting intensities having the comfort of daylight in the shade at noon on a clear Summer day. This industry will continue to grow, because it is rendering a real service to mankind.



. . . and Some Possible Design Combinations


Now, more than ever
AMERICA
WHAT

MUST SEE IT'S DOING!

It has been proved again and again that better lighting means less fumbling, fewer mistakes, better production with less strain—in our defense plants and in the offices and stores and factories which back up our defense effort.

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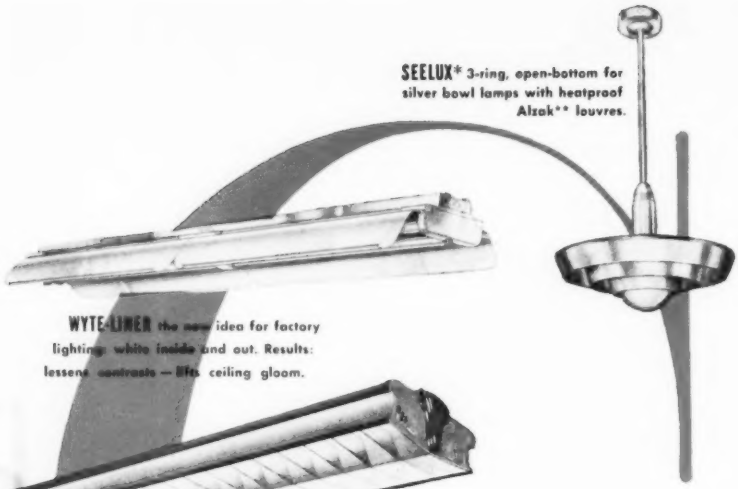
Day-Brite Lighting, Inc., St. Louis, Mo., America's leading manufacturer of fluorescent lighting fixtures.

IT'S EASY TO SEE WHEN IT'S . . .

DECIDEDLY BETTER
DAY-BRITE
Lighting Fixtures

124



SEELUX* 3-ring, open-bottom for silver bowl lamps with heatproof Alzak** louvres.

WYTE-LINER the new idea for factory lighting: white inside and out. Results: lessens contrasts — lifts ceiling gloom.

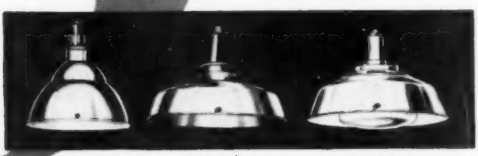
GUTHLITE® swings down for easy maintenance. 43% uplight, 57% downlight.

LITE-BLOX TROFFER Comprehensive line — ribbons of light — super constructed.

ARISTOLITE* Hinged glass panels swing apart for easy cleaning from floor.

Guth

the complete line of fluorescent *and* incandescent fixtures



High-Bay Dome Glass Alzak

INDUSTRIAL INCANDESCENT reflectors for better light control at the working plane.

These are merely a few examples. Our line includes any fixture for any effect you may wish.

It is easy to plan with GUTH fixtures

May we send you our catalog?

Guth LIGHTING

THE EDWIN F. GUTH COMPANY / ST. LOUIS 3, MISSOURI

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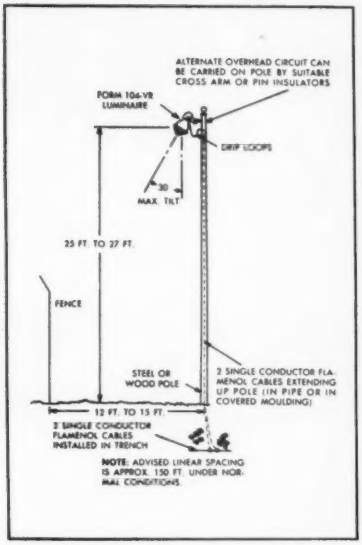
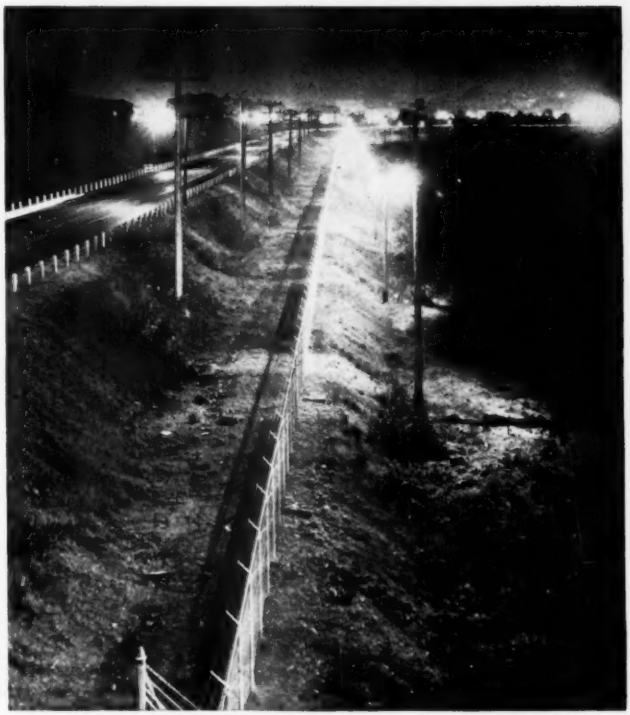
**Ⓡ and Patented, Aluminum Co. of America

OUTDOOR INDUSTRIAL LIGHTING


ALTERNATE OVERHEAD CIRCUIT CAN BE CARRIED ON POLE BY SUITABLE CROSS ARM OR PIN INSULATORS
FORM 104-VR LUMINAIRE
DRIP LOOPS
30° MAX. TILT
25 FT. TO 27 FT.
FENCE
STEEL OR WOOD POLE
2 SINGLE CONDUCTOR FLAMENOL CABLES EXTENDING UP POLE (IN PIPE OR IN COVERED MOULDING)
12 FT. TO 15 FT.
2 SINGLE CONDUCTOR FLAMENOL CABLES INSTALLED IN TRENCH
NOTE: ADVISED LINEAR SPACING IS APPROX. 150 FT. UNDER NORMAL CONDITIONS.

HIGH VISIBILITY along the fence is obtained by using G-E Form 104 VR luminaires. These units are equipped with a Universal Bracket with either external binding posts or cable-inlet bushings for series or multiple circuits.

INTRUDERS can't penetrate this "wall of light" without detection. At the same time, 6,000 or 10,000-lumen lamps keep operating costs down to reasonable levels.



How to Get Extra Protection with Modern Boundary Lighting

If the boundaries of your plant need 24-hour protection, a well-planned lighting system adds a lot to security at surprisingly little cost.

But it's important to get adequate illumination, for high visibility along the fence, without glare annoying to guards or adjacent property owners. The lighting must be effective in any weather, with safeguards against emergency outages.

A typical boundary-line installation uses G-E Form 104VR luminaries on 25-ft poles, 150 feet apart, as shown in the sketch above. Uniform two-way light distribution, with excellent lateral shielding, is the result.

To protect your plant property and to expedite plant traffic, illuminate loading platforms and parking lots. Whatever the need—General Electric has equipment matched to the job. The latest methods and layout guidance, too, are available to you from the lighting specialist at your local G-E office. You'll find valuable suggestions in the new bulletin, "Outdoor Lighting for Industrial Plants." For your copy, write Section 451-164, General Electric Company, Schenectady 5, N. Y.

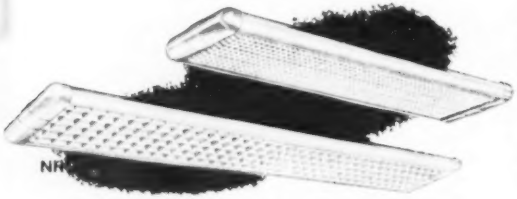
GENERAL ELECTRIC

451-164

• Better electrical contractors and dealers everywhere will look to Leader in the fifties for the latest in design, the finest in quality, the best in construction... regardless of the type of fluorescent fixture involved. They know they can depend on Leader for new styling, better engineering and low price . . . the three most important elements in any lighting installation. Next time you buy fluorescent fixtures, choose Leader and get the finest.

All fixtures shown can be installed individually or in continuous runs, ceiling mounted or suspended.

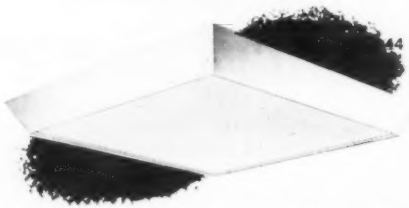
OFFICER SERIES



The fixture that brings glamour to commercial interiors! Streamlined and beautifully proportioned, with curved translucent plastic side panels, moulded one-piece plastic louver in choice of 45° or 51° shielding angle. Has steel channel and deep drawn end caps. Available for two, three or four 40-watt tubes. Slimline Officer series for two, three or four tubes in lengths from 48" to 96".

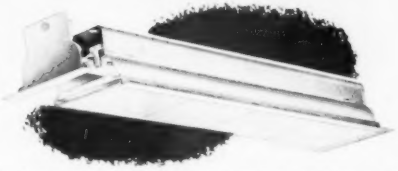
Adjustable incandescent spotlight available for use in line with Officer fixtures for effective and flexible highlighting of special areas. Use as insert between fixtures, at end of continuous runs, or at intersection of rows.

SQUARE SERIES



Leader's newest! These striking Square units furnish intensive light for selected areas and at the same time provide floods of non-glare light for overall illumination. For recessed, semi-recessed, surface or suspension mounting. The most popular size is 4' x 4', with choice of four, six, eight or ten lamps, either conventional 40-watt or T-12 single pin Slimline. Also available in 2' x 2', 3' x 3', 6' x 6' and 8' x 8' sizes. Larger size of fixture means fewer units to buy, to install, to service. Abundant light output eliminates necessity for special fixtures for highlighting. Steel channel, housing and side panels, featherweight plastic 40" x 40" louver.

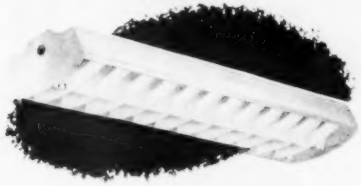
TROFFERLITES



Leader alone, of all manufacturers, offers a complete line of recessed troffer fixtures for versatile, efficient lighting. Leader Trofferlites, shown here with Holophane Controlens*, are available also with Factrolite, flat Albalite, curved Corning lens, and other special types of lenses. Open, louvered and baffled styles, too. Choice of flange trim or T-bar mounting construction, regular or shallow depth. For one, two or three 40-watt tubes, and for two or three Slimline tubes in choice of 72" or 96" length. Trofferlites in the 40-watt series are also available in all styles above in 24" width for special lighting applications.

*Copr. The Holophane Co.

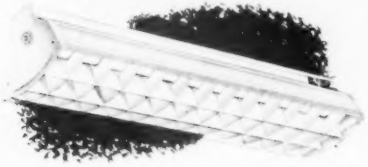
VARSITY



Offers you most for your money! Varsity fixtures furnish large light output at economical installation and maintenance costs. Not a "bargain" fixture—but quality engineered throughout to meet the demands of modest budgets. 60% downward, 40% upward illumination. V-shaped reflector for high light values, baffle-type louver for correct shielding. Channel and housing of steel, finished in white, high gloss baked enamel. For two, three or four 40-watt tubes. Slimline Varsity series for two, three or four tubes in lengths from 48" to 96".

look to LEADER for the finest!

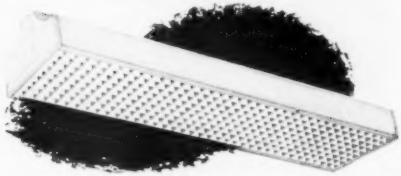
SCHOOLMASTER



Designed to provide 60% direct and 40% indirect illumination, Leader's Schoolmaster is ideal for lighting classrooms, libraries, other areas where light for close seeing is a constant requirement. Standard louver cut-offs of 25°-55° and 25°-45°. Available with or without built-in 15-watt or 30-watt germicidal lamp. (Natural room circulation causes air to pass through irradiated zone.)

Steel housing and channel, finished in white, high gloss baked enamel. Translucent plastic side panels available on request. For two, three or four tubes, either conventional 40-watt, or Slimline in lengths from 48" to 96".

NEW VARSITY

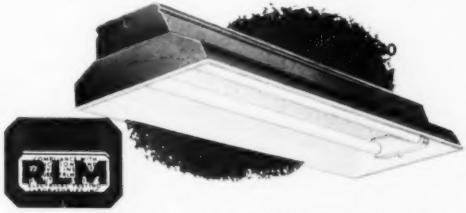


A luxury fixture at a budget price. Ribbed translucent plastic side panels add new beauty. Will not warp or discolor. Moulded plastic louver, with 40° x 40° shielding angle, "sifts" light for pleasing, efficient distribution. Upward light spill gives 40% indirect, 60% direct illumination. Steel parts finished in white, high gloss baked enamel, with satin-finish aluminum gray trim. For two, three or four tubes, either conventional 40-watt, or Slimline in lengths from 48" to 96".

LEADERALL Louvered Light Ceiling

Leaderall louvered grilles of featherweight plastic make it possible to have completely illuminated ceilings with a pleasing glow of even light from wall to wall. New ceilings can be finished to complement modern decorative schemes, and old ceilings modernized without making any structural changes. Leaderall plastic units, with 40° x 40° shielding angle, are held by adjustable tie rods to form a completely level, rigid ceiling at any desired height. Will not warp. Easily removable for quick re-lamping. Can be used with any type of fluorescent fixture. No interference with sprinkler system or air conditioning. Leaderall units are available in 2' x 4' and 4' x 4' sections. Other sizes, to fit curvatures or odd corners, available on special order.

STRATOLINER Industrial Series



The Stratoliner offers everything desired in a heavy duty, all-steel industrial fluorescent fixture. Durable, strongly built, neat in appearance, easily serviced. Model IUP-240, shown here, is for two 40-watt lamps, with closed end porcelain enamel reflector, RLM approved. Housing and exterior finished in gray baked enamel. Other 40-watt fixtures for two or three tubes, in choice of open or closed end reflectors. Powerful 85-watt Stratoliner series available for locations requiring higher mountings and wider spacing of units. Choice of open or closed end reflectors.

Leader

"maintenance time cut 50%"

with Westinghouse MERCURY lighting

A typical customer's problem: "To reduce the time spent on lighting maintenance."

Westinghouse recommendation: "To install Westinghouse Mercury Lighting."

Result: "Less than half as many fixtures to maintain and fewer lamps to replace, because mercury vapor produces more light per luminaire than any other lighting system."

This is only one case out of hundreds of "time-tested" installations. All show evidence that Westinghouse Mercury Lighting is a fast growing industry favorite. Investigate the complete line: 400, 1,000 and 3,000-watt units for either low or high-bay areas . . . open or closed fixtures for clean or dirty locations . . . high or low-voltage ballasts for any distribution system. Send for B-4727, **"Westinghouse Lighting at Work" in every industrial area.** Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

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Westinghouse

LIGHTING DIVISION

Edgewater Park, Cleveland

J-04294

Setting new standards in starter performance

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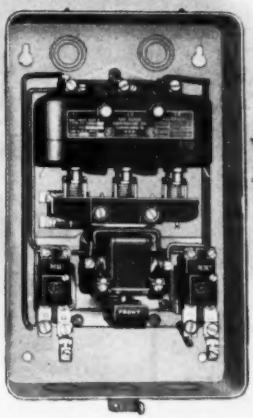
CLARK TYPE "CY" AC MAGNETIC MOTOR STARTERS

with the

NEW ARC QUENCHING PRINCIPLE

- No tools needed to inspect contacts. Contacts, coils, and stationary magnet frame easily removed.
- Melting alloy-type overload relays.
- Vertical lift clapper type magnet adapted to straight line guided movement, uses no springs.



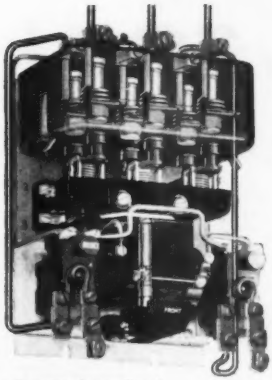
These rugged magnetic starters provide the extra protection and dependable operation of "Mill-Type" heavy-duty construction and design.

another CLARK *first!*

The CLARK Type "CY" Starters feature the combined use of strong multi-turn magnetic blowouts with twin-break contacts.

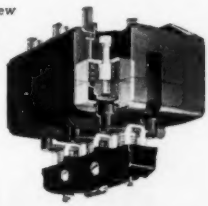
The Type "CY" starters employ an entirely new principle of arc interruption. The blow-out coils are concentric with the contacts. The magnetic field quenches the arc either by lengthening or confining it. By forced rotation the arc moves continually from a hot to a cold spot — minimizing burning or pitting of contacts. The solid upper arc shield prevents the accumulation of hot gases between wiring terminals—minimizing phase-to-phase failures*.

All parts in the arc chamber are copper, brass and steel, thus preventing carbonization. Absence of carbon and soot means longer contact life and lower operating temperatures.



Complete Power Circuit of CLARK Type "CY" Starter, Size 2

Phantom View Showing Arc Shield



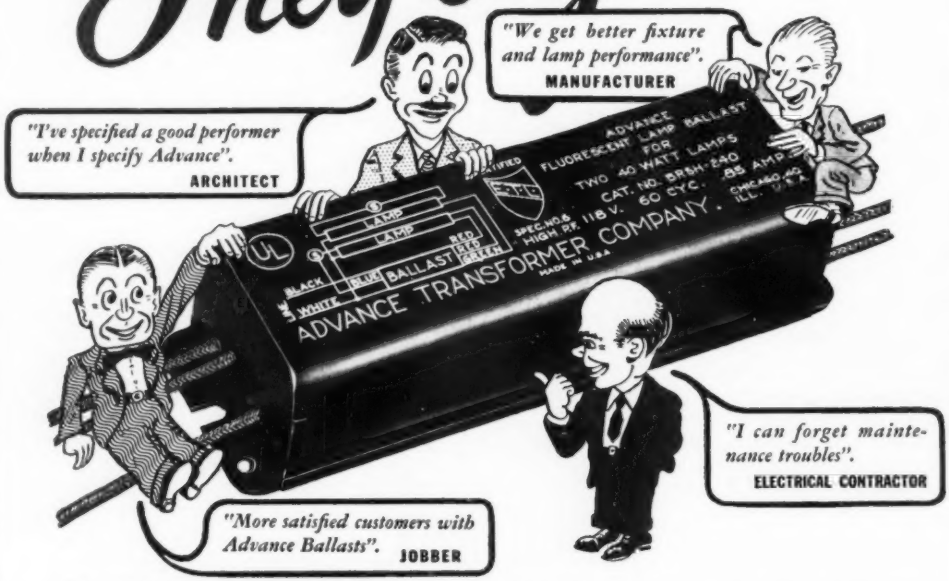
*Magnetic blow-out coils are used on all size 2 and 3 Type "CY" starters. Mill-Type construction is used on sizes 0 and 1.

Available Through **CLARK** *Distributors.*

THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1142 EAST 152ND STREET, CLEVELAND 10, OHIO

They Agree...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"I've specified a good performer when I specify Advance". ARCHITECT
ADVANCE FLUORESCENT LAMP BALLAST FOR TWO 40 WATT LAMPS
CAT. NO. BR8H-240 .85 AMP
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SPEC. NO. & HIGH P.F. 118 V.
CHICAGO 40 ILL. U.S.A.
ADVANCE TRANSFORMER COMPANY
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LAMP
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"More satisfied customers with Advance Ballasts". JOBBER

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WORLD'S LARGEST MANUFACTURER

DEVOTED *EXCLUSIVELY* TO THE ENGINEERING AND DESIGN OF **FLUORESCENT BALLASTS**

to meet the most exacting customer demands and specifications

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CABLE ADDRESS: ADTRANS

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OVERLOAD PROTECTION

FOR SMALL MOTORS

COMPLY WITH THE NATIONAL ELECTRICAL CODE

by using the Approved Bulletin 600 Starting Switch

Toggle lever switch with cover removed

Key operated for public places

For hazardous gases

For waterproof service

It looks like an ordinary snap switch . . . but something has been added . . . a self-contained thermal overload breaker. The heater element quickly detects an overload on the motor. It releases a soldered ratchet . . . the contacts snap open, automatically.

The motor is thereby disconnected before a burnout can occur . . . and it cannot restart until the toggle lever is flipped down manually to reset the overload breaker. If the overload persists, the contacts cannot be held closed by the operator.

This compact starter, rated at 1 hp, 110-220 v, is a favorite with engineers who want a small, inexpensive switch to protect fractional horsepower motors. Send for Bulletin 600.

Allen-Bradley Co.
1316 S. Second St., Milwaukee 4, Wisconsin

5-51-MR

A-B Quality

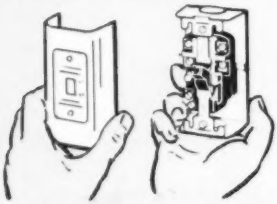
ALLEN-BRADLEY

BULLETIN 600 STARTING SWITCHES

QUALITY

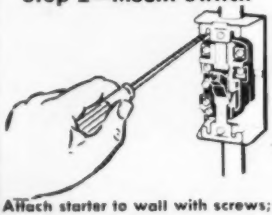
So Easy to Install...So Dependable in Service

Step 1—Remove Cover

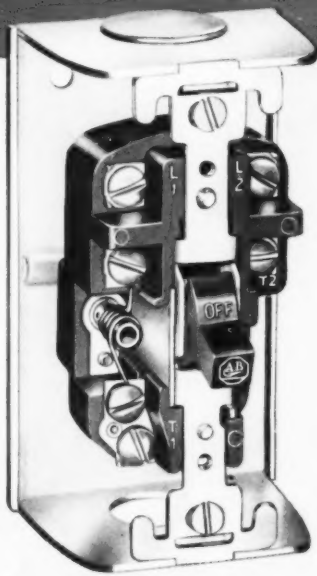


Simply remove two screws; metal cover then slips off easily, exposing the Bulletin 600 starter terminals.

Step 2—Mount Switch

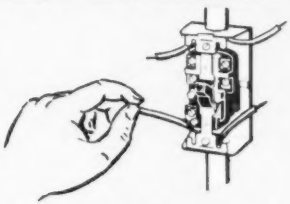


Attach starter to wall with screws; convenient conduit openings are located in the top, bottom, and back.



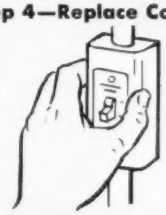
Bulletin 600—the ideal switch for starting and protecting small motors on unit heaters, stokers, fans, pumps, refrigerating compressors, grinders, and small machine tools.

Step 3—Wire and Connect



Line and motor wires can be easily pulled into the box without removing the starter from its enclosure.

Step 4—Replace Cover



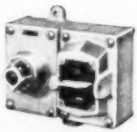
Cover is slipped on and secured with two screws. The Bulletin 600 installation is always quick and easy.

BULLETIN 600 MANUAL STARTING SWITCH for SMALL MOTORS

Two starters in one enclosure

Starter with selector switch

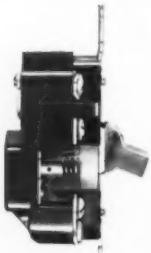
Starter with pilot light



Watertight starter with pilot light

In standard wall box

AVAILABLE IN ENCLOSURES FOR EVERY APPLICATION



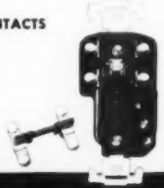
Side view of starter, showing heater element coiled around the stud.

THERMAL OVERLOAD BREAKER

Soldered ratchet of overload breaker is mounted on a heater stud. Around the stud is the coiled thermal element which heats the stud. Overload melts the solder; ratchet is released. This automatically opens switch with snap action.

DOUBLE BREAK SILVER ALLOY CONTACTS

Switch contacts are quick make, quick break. In the 2 pole construction, each side of line has two stationary contacts bridged by the double moving contacts. They need no contact maintenance, because they form no insulating oxides.



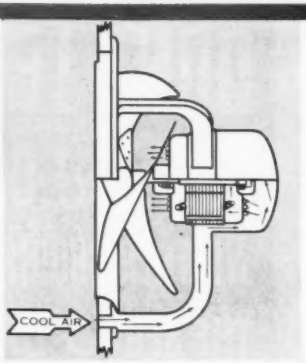
5-51-M

A-B Quality

ALLEN-BRADLEY

BULLETIN 600 STARTING SWITCHES

QUALITY



How ILG contributed to 50 fabulous years in the electrical industry

FIRST ILG "FIRST"—Patented ILG Self-Cooled Motor. When fan is operating, clean, cool, fresh air is drawn through the vent pipe from OUTSIDE, circulated through motor, then exhausted through front of motor. Motor stays clean, cools itself—no foul air reaches it to interrupt service, shorten its life.

CLOSELY interwoven in the fabric of the electrical industry's gigantic growth during the past half-century is the story of the ILG Electric Ventilating Co. It was in 1906 that Robert Ilg patented the now internationally famous Self-Cooled Motor for Propeller Fans.

Today—forty-five years later—the company operates its modern plant in Chicago solely for the manufacture of complete ventilating and heating units, each bearing a "One-Name-Plate" Guarantee. Today the company has branch offices in principal cities, staffed with trained engineers. Today the company has a network of distribution, nationally and internationally, that make ILG products quickly available. Today, electrical contractors, engineers, and dealers everywhere specify ILG equipment, knowing from experience that it will live up to every promise for full capacity, long life, low maintenance cost, and supremely quiet operation.

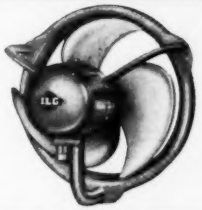
ILG
REG. U. S. PAT. OFF.

VENTILATION

ILG "FIRSTS"

1906—Self-Cooled Motor Propeller Fans
1907—Automatic Shutters
1907—Solenoid-operated Shutters
1912—Direct-connected Centrifugal Fans
1915—Power Roof Ventilators (Propeller Fan type)
1916—Steam Unit Heaters (Propeller Fan type)
1917—Electric Unit Heaters (self-contained)
1918—Attic System, Summer Cooling
1918—Motor-operated Shutters
1918—Portable Kitchen Ventilators
1925—Built-in Kitchen Ventilators
1925—Type C 1-phase Motors (condenser type)
1925—Transom Kitchen Ventilators
1934—Variable Air Control (Centrifugal Fans)
1939—Floated Drive (Centrifugal Fans)
1942—"Portvente" Porthole Ventilators
1947—Type "Q" Propeller Fans
1949—Ilgfarmaire for crop drying
1950—Self-Cooled Motor "PRV" Power Roof Ventilators (Centrifugal Fan type)

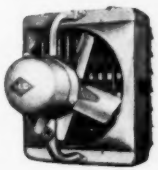
Out of ILG research in the past have come these many new developments, plus constant improvements in old products. Intensified research, using the amplified facilities of the recently completed ILG Research Laboratory, promise exciting ILG developments in the next fifty fabulous years!



ILG SELF-COOLED MOTOR PROPELLER FANS—*extra*-powerful, *extra*-quiet, *extra* long life. Quick, easy to install in wall, window, or on roof (in penthouse with automatic shutter).

ILG "PRV" POWER ROOF VENTILATORS—new centrifugal fan type for vertical flues and duct systems. An instant hit—the "PRV" is now making new friends everywhere.

ILG DIRECT-DRIVE CENTRIFUGAL FANS—available in a wide range of types and capacities for all kinds of air moving applications—general exhaust and supply, cooling, processing, etc.



ILG "VITAL ZONE" UNIT HEATERS—the finest heating equipment money can buy. Complete lines of steam, hot water, electric and gas-fired units are now available for continuous 3-shift operation.

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Panel Heat

—the new **INFRARED**
that pays for itself

Never Before

— SO MUCH HEAT
— SO QUICKLY RESPONSIVE
— SO ACCURATELY CONTROLLED at
— SO LITTLE COST

for
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ANY PRODUCTION QUANTITY
ANY HANDLING METHOD
ANY COLOR OR MATERIAL

1. No wiring in high heat zone.
2. All vital parts serviced externally.
3. *Low Thermal Mass* inside insulated enclosure means quick on-and-off heat response.
4. Lifetime reflectors in 3 optical designs.
5. Long-life radiant CALROD* heaters. Plug-in, lock-in. Standard makes, voltages, sizes.

*REGISTERED U.S. PATENT OFFICE

Heat capacity: 4 to 40 kw. at 800 to 8000 BTU/hr/sq. ft.

Build-as-you-go

—as easy as this:

Heater panels are field assembled on standardized interchangeable frame members, which also house the electric wiring; Makes later changes in size, production capacity, or heating cycle a matter of inserting or rearranging readily available standard parts.

Send for details now on Build-As-You-Go Panel Heat

- Insulated
- Non-Fragile
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Jensen Specialties, Inc.
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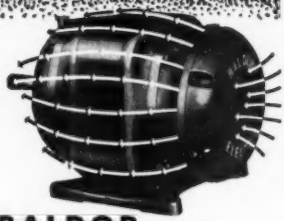
Requires so little attention—is so easy to install! Use it to boost production from your present oven or to handle that new heating job—in restricted space, in minimum installation time.

DON'T LET DUST, DIRT OR WEATHER SHORTEN THE SERVICE LIFE OF YOUR MOTORS



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Streamcooled

BALL-BEARING MOTORS

These motors are SOLIDLY ENCLOSED, cooled by an outer-mounted fan in the bell-end. They cannot inhale dust or dirt and will operate efficiently in all kinds of weather.

BALDOR Streamcooled Motors require no dismantling for cleaning. Thus *less servicing* . . . no interruption of pumping or other service. Let us tell you more about these long service-life BALDOR Motors.

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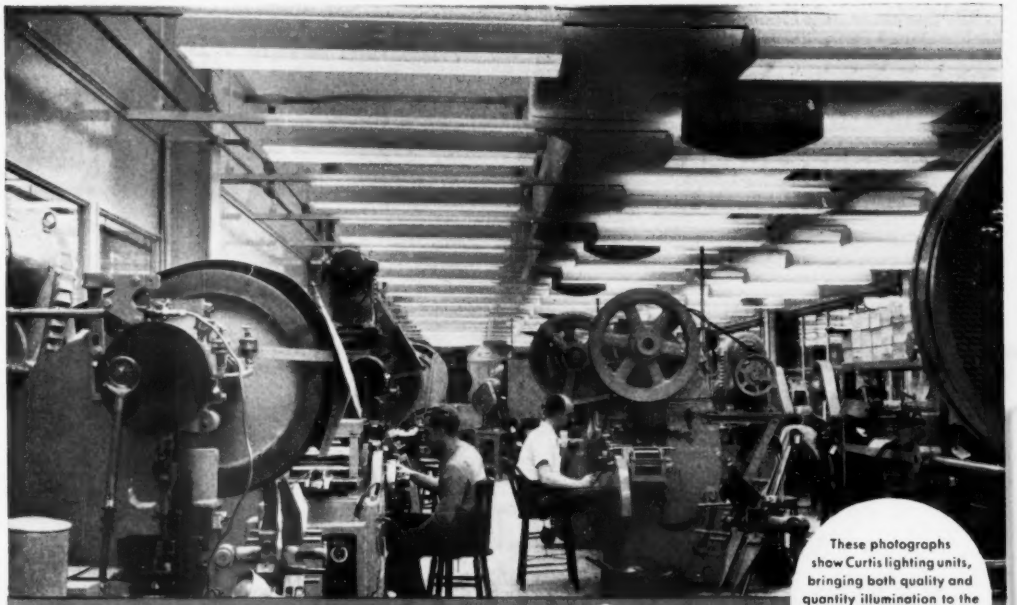
Baldor

Sold and serviced in more than 300 Trade Centers

CURTIS industrial lighting is engineered for . . . . . .



These photographs show Curtis lighting units, bringing both quality and quantity illumination to the Metals Controls Corporation plant in Attleboro, Mass.

PEAK PRODUCTION

CURTIS LIGHTING, INC.

WRITE for the complete, illustrated story of how Curtis Engineered Industrial Lighting brought an entirely new concept to an industrial lighting problem

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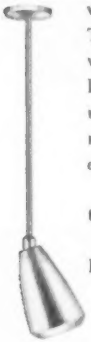
For today's finest accent lighting

AMPLEX SWIVELITES

FOR MODERN, EFFECTIVE and truly economical accent lighting, today's one first choice is Amplex Swivelites. They're made of aluminum with a permanent satin finish . . . designed for ultra smartness. Their unique double-ball swivel brings positive positioning with fingertip control. Cool, ventilated hoods prolong bulb life. And each Amplex Swivelite is composed of a few basic units which are interchangeable with every other! Arranging new lighting effects is vastly quicker and easier . . . far less expensive!



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By applying the principles of Progressive Design, Joleco has developed an approach to lighting which blends the "know-how" of fixture production with the application of latest lighting techniques. It combines the continuing study of ILLUMINATION with ENGINEERING and "remembers" these important features:

- Eye-Appeal and Correct Design . . . to fit in architecturally.
- Controlled Light . . . to give high quality glare-free illumination.
- Fixture Efficiency . . . to secure the best results possible and still maintain eye-appeal, design and controlled light.
- Ease and Simplicity of Installation . . . to keep down the cost of installation, yet furnish a precise job.
- Ease of Maintenance and Inspection . . . to provide quick accessibility to interior without the use of tools, reducing time and expense of maintenance.
- Balanced Cost . . . to provide economical first cost and a minimum of maintenance and operating cost.

Through this Joleco approach, we sincerely believe we give the Lighting Engineer the proper tools to solve his lighting problem, the Electrical Contractor equipment easy to install, and the Customer the utmost for his investment in lighting.

Fixtures that Emphasize Progressive Design

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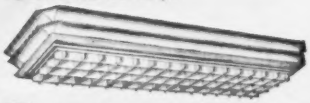
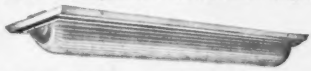
F10 . . . Unshielded General Purpose Fixtures—one, two and four lamps.

F40 . . . Beautiful Recessed Fixtures—five designs, two and four lamps.



F50 . . . Fine Commercial Fixtures—six designs, two, four and eight lamps.

F51 . . . A companion to the F50—two lamps.



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clip-on louvre

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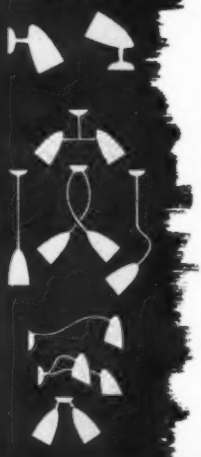

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Simple touch control!
Maximum adjustment!

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SOLA *Sequenstart*
CONSTANT VOLTAGE BALLASTS
operate with

minimum ballast maintenance

They are designed to last the life of the fixture.

SOLA Ballasts are designed to be installed in a fluorescent fixture and then forgotten. Capacitor heat failure (principle cause of ballast malfunctions) is virtually eliminated with the patented SOLA ventilated capacitor compartment. Special core and coil construction, high vacuum impregnation and baking and low operating temperatures all contribute to the long trouble-free life of SOLA Ballasts. So, if you are looking for a fluorescent light ballast that you can specify with peace of mind make it a SOLA. You'll find that when it's a SOLA Ballast . . . "You can install and forget it."

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We welcome any questions you have about ballast design and application. Write for technical bulletin J-PFL-144.

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Sequenstart
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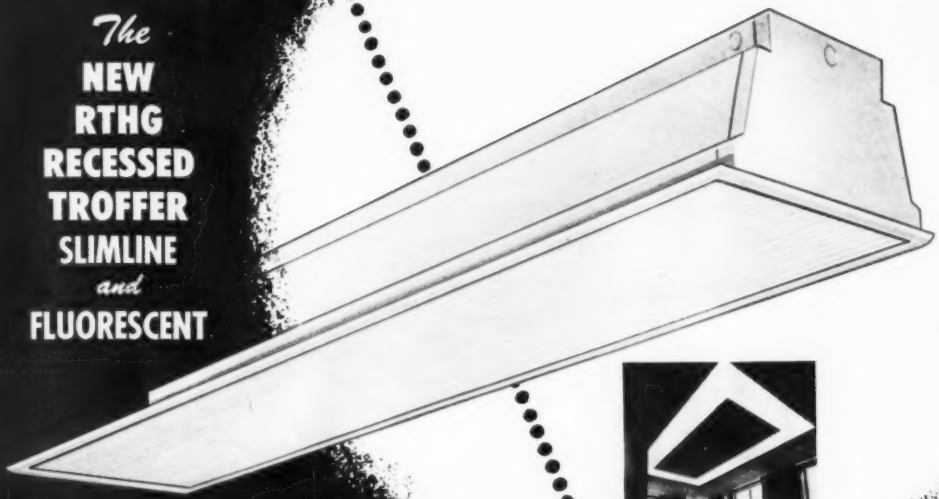
All-bright . . . HAS ACCOMPLISHED

The **NEW RTHG RECESSED TROFFER SLIMLINE** *and* **FLUORESCENT**



4, 5, 6, & 8 FT.
1, 2 & 3 LITE

It's there BUT IT'S NOT EXPOSED*

MAGIC FRAME

IT HINGES No Exposed Hinges
IT'S REMOVABLE No Screws
IT LOCKS No Exposed Catches

The RTHG is designed for even distribution of light . . . Adaptable for geometrical layouts of cross lighting, squares, L's, T's, X's, or V's which eliminates shadow, reflected glare, stroboscopic effect. *Available with Egg Crate Louvre. MOUNTING Individual or Continuous Runs.*

Merely Hang, Raise and Lift to Insert and Lock in Place.
Just Lift and Shift to Hinge or Remove.

*(ALL ARRANGEMENTS ARE INVISIBLE)

ALL-BRIGHT ELECTRIC PRODUCTS CO.
3917 NORTH KEDZIE AVENUE • CHICAGO 18, ILLINOIS

COPYRIGHT 1951

L-M Protective Lighting is PRODUCTIVE Lighting

No dark hideaways for intruders, even in this back alleyway. A Spherolite installation.

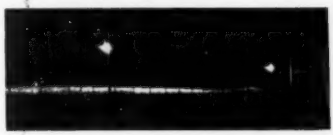
Protection is only *half* the story when you install L-M plant-protective lighting.

PRODUCTION, not only during the present emergency, but in the years to come, is an equally important consideration in every L-M installation.

L-M Lighting Engineers, backed by more than 35 years of experience with outdoor lighting, are designing installations which not only meet War Standards Requirements but also provide additional light on loading docks, railroad sidings, yards, storage areas, parking lots and entrances.

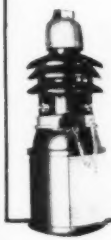
Dark spots are potential production-bottlenecks. They can also be scenes of lost-time accidents. By eliminating these dark areas, L-M Protective Lighting installations will continue to pay off for years to come.

A lighted fence, with controlled light directed at the fence and beyond. Guards patrol roadway in semi-dark at right of picture.



Over-the-fence lighting, with glare on any approaching intruder. Typical use of L-M Fresnelite.

Two L-M Protective Lighting Units



L-M Spherolite provides 5 different light patterns. Combinations of reflectors and refractors to provide correct light pattern for almost any requirement. When equipped with L-M Autolatch, it can be serviced from ground with lamp stick; no ladder needed.

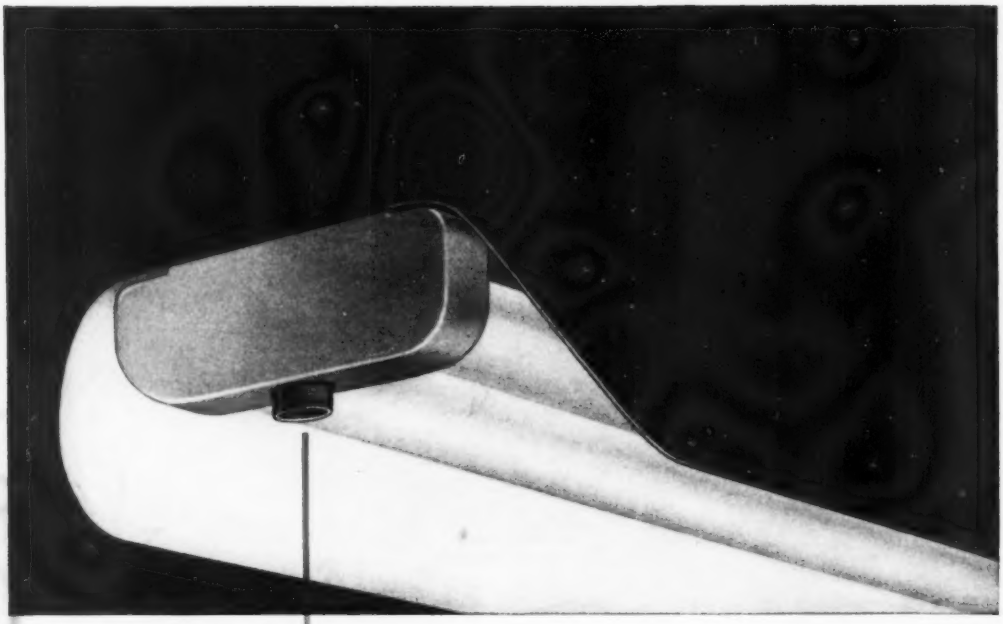
L-M Fresnelite—specially designed glare unit to provide a broad, fan-shaped light pattern. Ideal for over-the-fence lighting.

GET THIS LIGHTING BULLETIN

Ask the L-M Field Engineer for L-M's bulletin on Protective Lighting. Describes L-M Lighting Engineering Service and L-M Luminaires. Or write Line Material Company, Milwaukee 1, Wisconsin (a McGraw Electric Company Division).

LM®

LINE MATERIAL...Protective Lighting



Red button stops flicker caused by failing lamps

The red button on a G-E Watch Dog* starter is your sign of fluorescent lighting that will pay off in better light and decreased lighting maintenance.

For better light, Watch Dog starters promote even, continuous lighting—because Watch Dog starters banish flicker. When an aging lamp begins to blink, out pops the red button, and the lamp is turned off. When the lamp is replaced, the maintenance man pushes the button and the starter's ready to go again.

For decreased lighting maintenance, Watch Dogs prolong the life of ballasts and starters themselves by eliminating the overheating that results from blinking lamps.

LOOK FOR THE G-E NAME

Make sure all the fluorescent fixtures you install are equipped with Watch Dog starters. Look for the G-E identification, and look for the red reset button that means low maintenance and good light. Write to Section Q65-718, Construction Materials Department, General Electric Company, Bridgeport 2, Connecticut.

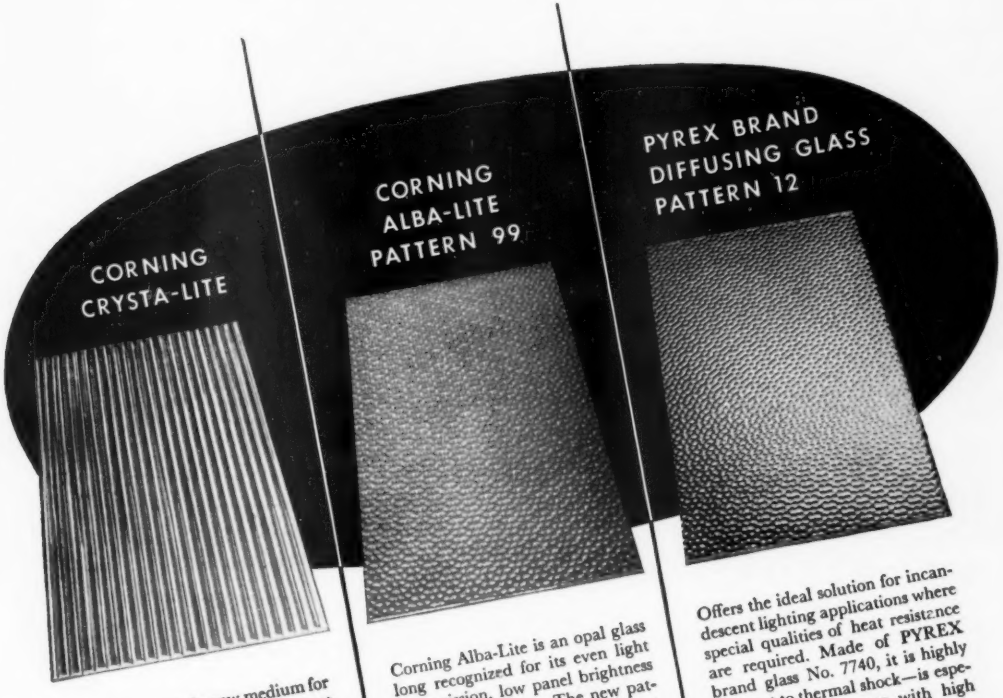
** Registered Trade Mark of General Electric Company*

GENERAL ELECTRIC

ANNOUNCING

Three New Additions To Corning Engineered Lightingware

As a result of a continuing effort to give you new and better lightingware, Corning research has developed three new additions to the Corning line. Like all Corning Engineered Lightingware, they provide maximum efficiency, effective light control, and design flexibility. The coupon below will bring you complete information on these important new products. Mail it today.



Here is an entirely new medium for prismatic control of fluorescent light. Utilizing linear prisms, it controls the distribution of light by bending high angle rays downward into zones where they are useful for illumination—gives you higher intensities with fewer fixtures and accurate brightness control. Efficiency is high. Made of water-white crystal, Corning Crysta-Lite is light in weight and non-color selective. Available in widths up to 24″, lengths up to 100″.

Corning Alba-Lite is an opal glass long recognized for its even light transmission, low panel brightness and high efficiency. The new pattern 99 is uniformly pebbled on one side to give greater "hiding power" —outline of light source is completely diffused. It makes for pleasing fixture appearance, is easy to clean. Available in (⅛″ thick), widths up to 24″ and lengths up to 100″, Alba-Lite Pattern 99 is easily cut to special shapes or made into bends as required.

Offers the ideal solution for incandescent lighting applications where special qualities of heat resistance are required. Made of PYREX brand glass No. 7740, it is highly resistant to thermal shock—is especially suitable for use with high wattage lamps or in outdoor installations. The uniformly pebbled surface provides excellent diffusion and even illumination. Available in widths up to 24″ and lengths up to 60″ (⅛″ thick), it can be cut to any required shape.

PYREX

CORNING GLASS WORKS

CORNING, NEW YORK

1851 *Corning means research in Glass* 1951

CORNING GLASS WORKS, Dept. EL-7, Corning, N. Y

Please send information on:

☐ Corning Crysta-Lite ☐ Alba-Lite Pattern 99

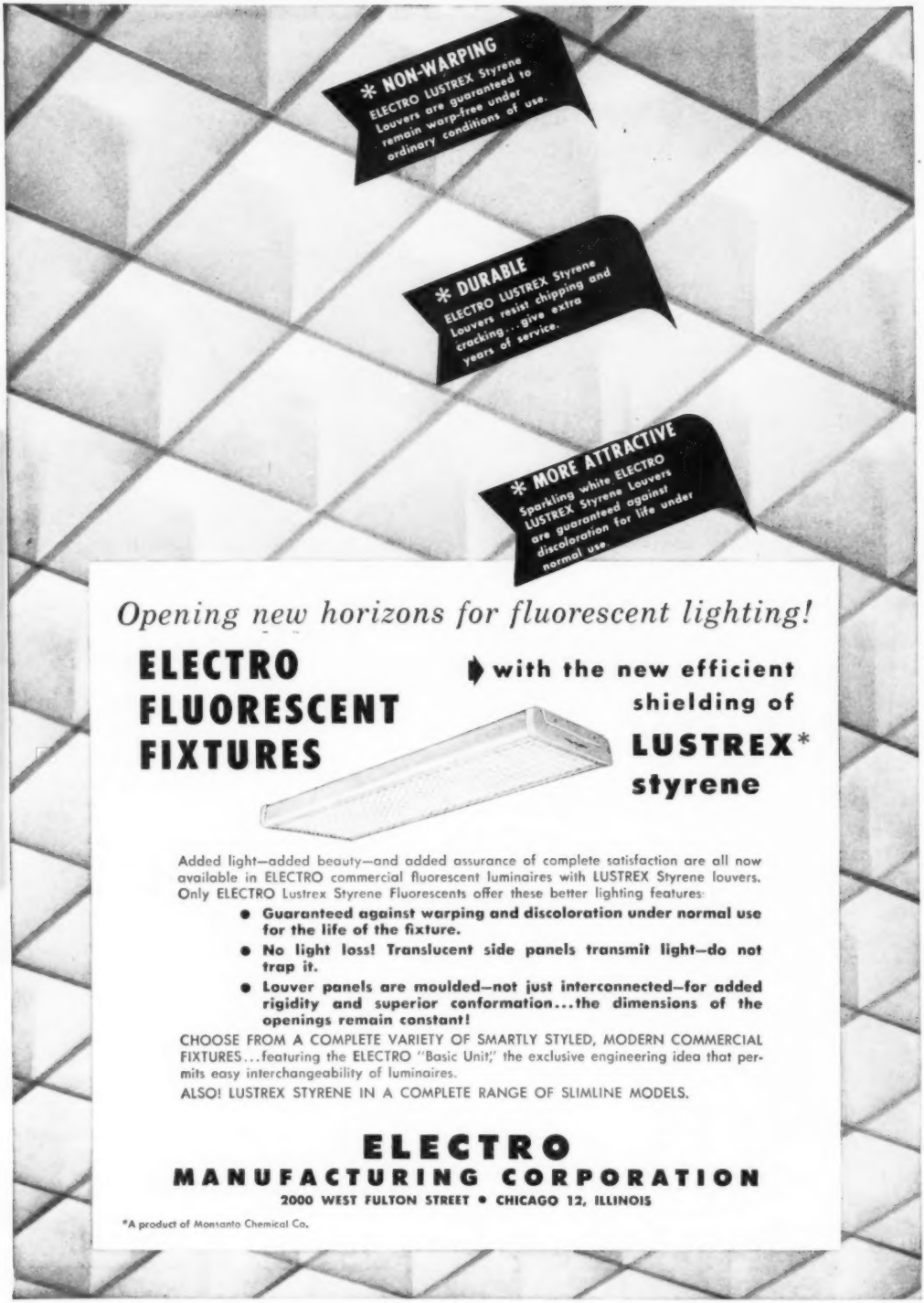
☐ PYREX brand Diffusing Glass Pattern 12

Name_____ Title_____

Firm_____

Address_____

City_____ Zone____ State_____


* NON-WARPING
ELECTRO LUSTREX Styrene Louvers are guaranteed to remain warp-free under ordinary conditions of use.
* DURABLE
ELECTRO LUSTREX Styrene Louvers resist chipping and cracking...give extra years of service.
* MORE ATTRACTIVE
Sparkling white ELECTRO LUSTREX Styrene Louvers are guaranteed against discoloration for life under normal use.

Opening new horizons for fluorescent lighting!

ELECTRO FLUORESCENT FIXTURES

with the new efficient shielding of LUSTREX* styrene

Added light—added beauty—and added assurance of complete satisfaction are all now available in ELECTRO commercial fluorescent luminaires with LUSTREX Styrene louvers. Only ELECTRO Lustrex Styrene Fluorescents offer these better lighting features:

- **Guaranteed against warping and discoloration under normal use for the life of the fixture.**
- **No light loss! Translucent side panels transmit light—do not trap it.**
- **Louver panels are moulded—not just interconnected—for added rigidity and superior conformation...the dimensions of the openings remain constant!**

CHOOSE FROM A COMPLETE VARIETY OF SMARTLY STYLED, MODERN COMMERCIAL FIXTURES...featuring the ELECTRO "Basic Unit," the exclusive engineering idea that permits easy interchangeability of luminaires.

ALSO! LUSTREX STYRENE IN A COMPLETE RANGE OF SLIMLINE MODELS.

ELECTRO MANUFACTURING CORPORATION

2000 WEST FULTON STREET • CHICAGO 12, ILLINOIS

*A product of Monsanto Chemical Co.

NO ROOM FOR GLARE—Corrugated white translucent PLEXIGLAS panels form a 600-square-foot, wall-to-wall luminous ceiling in this laboratory of the Excel Pharmacal Company, in New York City. Throughout the room, the evenly diffused illumination provides pleasant, efficient lighting. Note the low source brightness and minimum brightness contrast between ceiling, floor, walls and working surfaces. The lapped acrylic plastic panels are suspended on T-bars 14" below fluorescent tubes running parallel to the corrugations.

PLEXIGLAS Luminous Ceiling Passes Tough "Lab-Lighting" Test

Lighting gets a real test in Excel Pharmacal Company's laboratory—where critical visual tasks demand the best possible illumination. The PLEXIGLAS luminous ceiling passes that test easily—diffuses light completely—virtually eliminates glare and shadows—creates a luminous environment, easy on the eyes and nerves.

PLEXIGLAS acrylic plastic also simplifies the design, installation and maintenance of lighting systems. Because it is so easily cut, shaped and fabricated, PLEXIGLAS is being widely used in coffer and cove lighting, as overhead diffusing panels, and for completely enclosed fixtures. Strength and light weight make it easy and economical to ship and erect. And resistance to discoloration and breakage cuts maintenance costs to a minimum.

In more and more laboratories, drafting rooms, schools, offices—wherever close visual work makes *efficient* lighting essential—you'll find PLEXIGLAS. For full details of this durable, light-diffusing acrylic plastic, simply write us on your business letterhead.

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

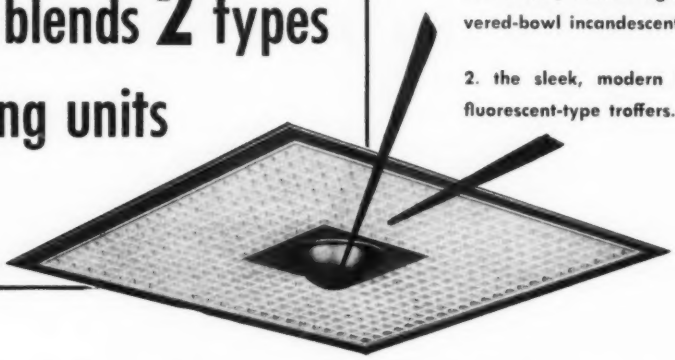
Representatives in principal foreign countries

• A steadily increasing percentage of PLEXIGLAS production, now at record levels, is required for the defense mobilization program. The supply available for civilian applications is limited.

PLEXIGLAS *is a trade-mark, Reg. U. S. Pat. Off. and in principal foreign countries.*

Canadian Distributor: *Crystal Glass & Plastics, Ltd., 54 Duke Street, Toronto, Ontario, Canada*

Skylike blends 2 types of lighting units into 1



1. the soft, indirect light of silvered-bowl incandescent lamps.

2. the sleek, modern look of fluorescent-type troffers.

Silvray's SKYLIKE lighting system offers your commercial customers many advantages not found in any other lighting system, yet uses only silvered-bowl incandescent lamps.

Designed along modular concepts for recessed or semi-recessed use, SKYLIKE fixtures may also be surface-mounted in old or remodeled interiors without sacrifice in lighting quality.

Silvray SKYLIKE units are amazingly economical in initial cost — only ½ to ⅓ as much as other equipment delivering comparable results. Fixtures fit 24" x 24" ceiling tile . . . are light in weight for quick installation. Simplicity in wiring and construction eliminates costly service call-backs. In addition, your customers take advantage of continued maintenance savings, for SKYLIKE units can be relamped from the floor and require only an occasional cleaning with a damp cloth.

Here's *real* proof of SKYLIKE efficiency

These unretouched photographs demonstrate the versatility of the SKYLIKE louvered incandescent lighting system.

In each case, the only light source used was that of the SKYLIKE units — note the soft, even distribution of light . . . the complete absence of glare, harsh shadows, and sharp light cut-off lines.

Photo by Milton Mann Studios

A unique SKYLIKE application is pictured here in the showroom of Irving A. Belking Furs in San Francisco, California.

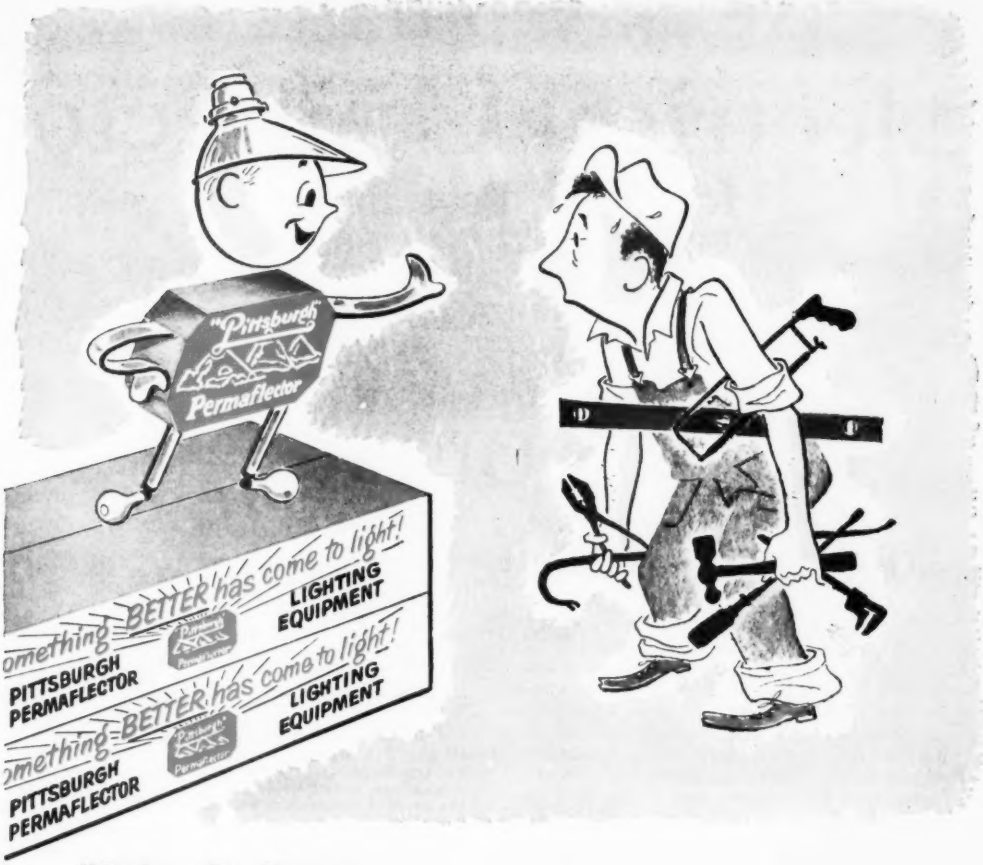
Notice how architect Bernard J. Saboroff's gridwork of 1 x 6 pine serves to hide the unsightly high ceiling, as well as to support the patterned group of recessed Silvray SKYLIKE units. Low brightness levels and 90° shielding provide an extremely satisfactory result.

Selected for warm color and ease of installation, surface-mounted SKYLIKE units replaced out-moded globe-type units in the remodernization of the Levy Brothers Store in Elizabeth, N. J.

Variable lamp sizes — from 150 to 500 watts — permit day-to-day changes in lighting intensities. Units can also be converted for accent or directional lighting by use of a semi-silvered lamp and accessory.

Send for complete SKYLIKE information. A comprehensive booklet describing the SKYLIKE system is yours for the asking. To get your copy, write Graybar Electric Company, Inc., Graybar Building, 420 Lexington Avenue, New York 17, New York. S18-47

SILVRAY LIGHTING INC.



"Take it Easy... the Job's Half Done!"

The job's half done when you install Pittsburgh Permaflector Lighting Equipment. All Fluorescent Units come compactly wired and ready-to-install. They go up quickly and easily. They save many man hours of installation time.

In end-to-end mounting, Pittsburgh Permaflector Fluorescent Units lock together and align perfectly. Squares and other patterns are a "natural" to install.

Next time—take it easy. Use time-saving, labor-saving Pittsburgh Permaflector Lighting Equipment.

PERMAFLECTOR PETE SAYS:

"Pittsburgh Lighting + Saved Manhours = MORE" PROFIT

Write today for full profit advantages of working with flexible Pittsburgh Permaflector Lighting Equipment.

"Pittsburgh" Permaflector

Pittsburgh Reflector Company

404 OLIVER BUILDING · PITTSBURGH 22, PENNSYLVANIA

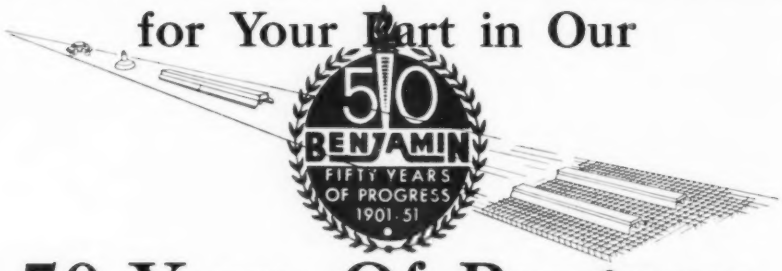
Permaflector Lighting Engineers in All Principal Cities

DISTRIBUTED BY ELECTRICAL WHOLESALERS EVERYWHERE • PERMAFLECTOR LIGHTING ENGINEERS IN ALL PRINCIPAL CITIES

We Say Thanks . . .

Electrical Contractor

for Your Part in Our



50 Years Of Progress

and take this opportunity to Restate the Principles upon which You and Benjamin will Continue to Progress Together

* * *

BUSINESS successes are made up of a lot of things. But behind EVERY business are the policies and people who make it grow. The high acceptance and widespread usage of Benjamin Industrial and Utilitarian Lighting Equipment today justifies the confidence that Benjamin has placed in the Electrical Contractor. His support and efforts in introducing, planning and installing Benjamin Lighting Systems has been a major contribution to Benjamin's growth.

That's why today, as Benjamin celebrates its Fiftieth Anniversary, we salute the Electrical Contractor, and pledge ourselves—with renewed faith—to continue our policy of assisting him in every possible way.

Just 22 years after Edison invented the electric lamp, the Benjamin Electric Mfg. Co. was started on an idea. That idea—the Benjamin Wireless Cluster—was dedicated to the better utilization of the electric lamp. It was the first successful attempt to increase the amount of light from a single outlet. From the first Wireless Cluster to today's world-famous "Sky-Glo" and "Magna-Flo" Lighting Systems, part of a complete line of over 2,000 lighting products, Benjamin has continued to pioneer lighting advancements for the better utilization of the electric lamp.

As we look ahead to another 50 years of lighting progress we rededicate ourselves to these responsibilities.

TO MAINTAIN OUR RELATIONS WITH THE INDUSTRY. To continue to work for and with the people and organizations in the lighting industry—the electrical contractors, distributors, architects, public utilities, and the users of commercial and industrial lighting.

TO REMAIN THE PIONEER AND LEADER. Never to relax our efforts to keep abreast and ahead of trends in product development. On our drawing boards now are promises of greater-than-ever lighting advancements to come.

TO GUARD BENJAMIN QUALITY. To maintain the company's products at uniform standards of quality, performance, durability and construction.

TO STRENGTHEN THE POSITION OF THE INDUSTRY. To this end Benjamin will continue to support and take an active part in all constructive industry activities devoted to the advancement of Illuminating Engineering as presently represented by NEMA, RLM Standards Institute, Illuminating Engineering Society, and the International Lighting Expositions.

Our obligations to the lighting industry in research and engineering, in production and distribution, will be carried into future generations. Our business is lighting—a science devoted to better seeing. Our aim is to search unceasingly for means of improving seeing conditions for people everywhere.

BENJAMIN ELECTRIC MFG. CO., DES PLAINES, ILL.

* * **BENJAMIN** * *

Lighting Equipment

B5365R

BRING OUT **BUILT-IN PERFORMANCE** OF MOTORS, MACHINERY AND EQUIPMENT FOR **MAXIMUM SAFETY**

Presenting ARROW AH HART

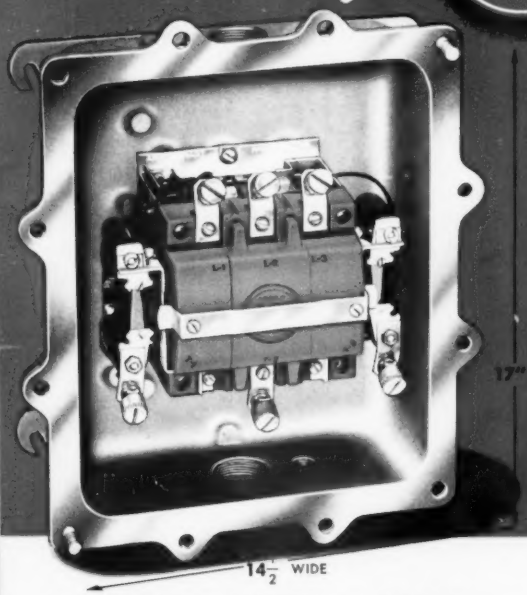
EXPLO-SAFE®

AND WEATHERPROOF

MOTOR STARTER LINE

FOR USE WHEREVER

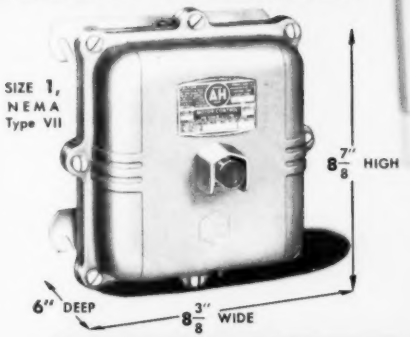
HAZARDOUS CONDITIONS EXIST



- *2/3* the SIZE
- *2/3* the WEIGHT
- SUPERIOR PERFORMANCE
- HIGHEST RESISTANCE to CORROSION
- STARTER and CONTACTOR SIZES 0, 1, 2, 3, 4

COMPLETE LINE •• UNIFORM DESIGN

Wherever hazardous conditions exist, specify and buy the finest motor control for machinery and equipment — EXPLO-SAFE MOTOR STARTERS by ARROW-HART. In a new, improved cast Feraloy enclosure, these "RA" Magnetic Starters, acclaimed by design-engineers, manufacturers and electricians alike for outstanding performance, are now available in NEMA Type VII, Class I, Group D; Type IX, Class II, Groups E, F, G; and Type IV. Consider these important features — (1) Feraloy housings, possessing high tensile strength and unusual resistance to corrosion, are cast of a special alloy by Crouse-Hinds. (2) Just 2/3 the size of outmoded solenoid type starters. (Compare dimensions listed on reverse side.) This means new opportunities in layout and more compact control centers. (3) Just 2/3 the weight is welcomed by installation and maintenance crews. (Compare weights on next page.) Accumulated floor load is materially reduced. (4) Right Angle design innovations combined with alkyd hood and base assure full protection. For additional information note EXPLO-SAFE folder offer and product data on following page.



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APPROVED BY THE UNDERWRITERS' LABORATORIES

THE ARROW-HART & HEGEMAN ELECTRIC CO.

HARTFORD CONNECTICUT

BRANCHES AND WAREHOUSES IN PRINCIPAL CITIES

ELECTRICAL CONTROL

ARROW AH HART

ESTABLISHED IN 1890

ELIMINATE COSTLY INSTALLATION PROCEDURE

PROVIDE MAXIMUM SAFETY WITH

EXPLO-SAFE©

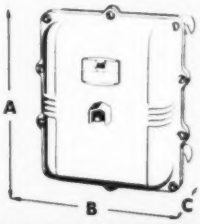
INSTALLING SIZE 2 EXPLO-SAFE STARTER

COMPLETE LINE OF MOTOR CONTROLS FOR OUTSTANDING PERFORMANCE IN HAZARDOUS LOCATIONS

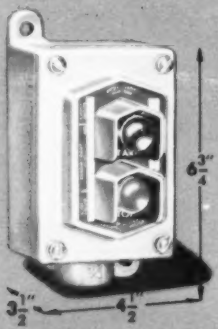
SMALL IN SIZE ***LIGHT IN WEIGHT***

There's increased protection for hazardous locations with Arrow-Hart's new EXPLO-SAFE and Weatherproof Magnetic Starters . . . a complete line of uniform design available in NEMA Type VII (Explosive Gas), Type IX (Explosive Dust) and Type IV (Weatherproof). There's superior performance, too, in the "RA", Right Angle, operating mechanism . . . a revolutionary design that accounts for 2/3 reduction in size and weight. Straight-thru front wiring . . . simple parts replacement with ample working space . . . make these starters easier, less costly to install and service. Heavy-duty contacts; simple, sturdy construction; guided-alignment — all combine to give you long, dependable service in the smallest motor starter line on the market.

COMPARE WITH MOTOR STARTERS NOW EMPLOYED



ARROW-HART EXPLO-SAFE PUSH BUTTON STATIONS



In hazardous locations for circuits up to 600 volts A.C. maximum. Push Buttons are available in variety of arrangements and contact requirements. Rotary type selector switch provides 2 or 3 position operation. Pilot lights with colored lenses also available. Stations custom assembled from stock parts for your specific needs.

TYPE 27907-E

DIMENSIONAL AND WEIGHT DATA FOR ACROSS-THE-LINE STARTERS

SIZE	A—HEIGHT	B—WIDTH	C—DEPTH	TOTAL WEIGHT (lbs.)
	Dimensions In Inches			
NEMA Type VII, Class I, Group D, Explosive Gas and Vapors				
0	8 7/8	8 3/8	6	18
1	8 7/8	8 3/8	6	18
2	14 1/8	11 5/8	7 9/16	59
3	17	14 1/2	9 1/8	106
4	23	17 7/8	11	233
NEMA Type IX, Class II, Groups E, F, G, Explosive Dust, Fibers and Flyings				
0	8 7/8	8 3/8	5 5/8	14
1	8 7/8	8 3/8	5 5/8	14
2	13 3/4	11 5/16	6 3/4	34
3	15 3/4	13 5/16	8 5/16	52
4	22	17	9 3/4	132
NEMA Type IV, Weatherproof				
0	8 7/8	8 3/8	5 5/8	14
1	8 7/8	8 3/8	5 5/8	14
2	13 3/4	11 5/16	6 3/4	34
3	15 3/4	13 5/16	8 5/16	52
4	22	17	9 3/4	132

APPROVED BY UNDERWRITERS' LABORATORIES

WRITE TODAY — FOR COMPLETE ENGINEERING DATA ON EXPLO-SAFE STARTERS

ARROW-HART

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
103 HAWTHORN STREET
HARTFORD 6, CONNECTICUT, U.S.A.

Branches In: BOSTON, CHICAGO, CLEVELAND, CINCINNATI, DALLAS, DENVER, DETROIT, LOS ANGELES, NEW YORK, PHILADELPHIA, SAN FRANCISCO, SYRACUSE. In Canada: ARROW-HART & HEGEMAN (CANADA) LTD., MT. DENNIS, TORONTO

PRINTED IN U.S.A.

Store Lighting Patterns for better Profits

See how Sylvania Trimline Fixtures conform to this store's arrangement... brighten up all display and working areas.

Quickly modernize store lighting with custom-fitted Sylvania Trimline Fluorescent Fixtures and Trimspots.

Now you can make store lighting work *extra hard*...earn *extra profits* for your customers, too!

With flexible Sylvania Fluorescent Trimline Fixtures and Trimspots you can concentrate light exactly where it is needed most. You can enable retailers to accent special items, get maximum sales benefits. At the same time they'll enjoy attractive, modern ceiling lighting patterns.

A complete line

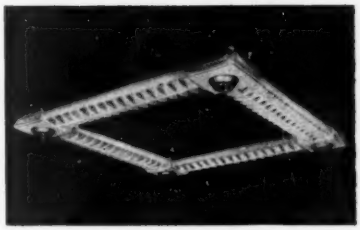
Sylvania Trimline Fixtures form a *complete* line. Handsomely "Miracoated" in sparkling white, they are now available in sizes and types for every need. Equipped with 2 or 4 Sylvania long-life fluorescent tubes. Standard or instant start... louvered or plastic shielded.

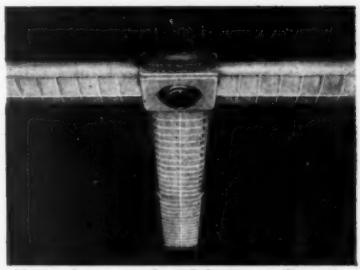
So, whatever your customers' lighting problems or modernization plans, get all the facts about Sylvania Trimline Fixtures. With Trimline you're *in* line for more business... more profits.

New illustrated folder shows all fixtures and gives complete data. For your copy, write to: Sylvania Electric Products Inc., Dept. L-6107, 1740 Broadway, New York 19, N. Y.

QUALIFIED LIGHTING CONTRACTOR SYLVANIA SALES SERVICE

Display this emblem as your customers' guide to you, the Qualified Lighting Contractor.





Shown above are a few of the many ceiling patterns now possible with Sylvania Trimline Fixtures and Trimspot..

SYLVANIA ELECTRIC

FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; PHOTOLAMPS; TELEVISION SETS

..YOU WANT THIS ROTOR DESIGN...

It's Copperspun!

If you buy or use motors, chances are that most of them are of the polyphase squirrel cage type — the most widely used class of integral horsepower motors made — for sustained heavy-duty drives in almost every class of service.

In rotor design, such service separates the good from the poor — and highlights your need for Fairbanks-Morse motors with Copperspun rotors, made through an exclusive centrifugal casting procedure developed by Fairbanks-Morse.

For in Copperspun rotors, you get the benefits of superior electrical characteristics — plus a design that is mechanically stronger for withstanding the most severe working conditions.

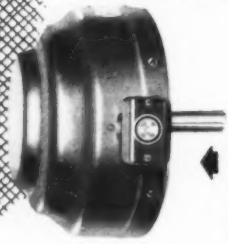
FAIRBANKS

A NAME WORTH

FOR POLYPHASE SQUIRREL-CAGE MOTORS

with Copperspun Rotors!

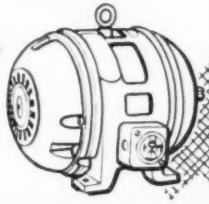
Here are a few in the complete Fairbanks-Morse line



GENERAL PURPOSE, drip-proof motors mountable in any position with full protection against flying chips, falling particles, dripping liquids, etc.

AXIAL AIR-GAP MOTORS: Averaging 30% lighter and 40% shorter overall—with flywheel effect three times that of corresponding ratings of conventional motors. Add to appearance, decrease size and weight of any driven machine. Meet all AIEE and NEMA standards.

TOTALLY ENCLOSED FAN-COOLED motors operate economically, safely under adverse conditions, including corrosive gas, vapors, steam or where metallic particles, abrasive dust and/or other materials are in the air. Available with Underwriters labels for use in Class 2, Group G hazardous locations.



FOR THESE EXCLUSIVE ADVANTAGES

Compare!

The Fairbanks-Morse Copperspun rotor design shows up at its best under comparison. It contrasts the mechanical strength and superior electrical characteristics of copper—against the poorer showing of aluminum and other white metal alloys. It contrasts new standards for uniformity and strength made possible through its precisely controlled centrifugal casting—against the results obtainable through standard, even old-fashioned, manufacturing procedures.

Finally, comparison drives home the virtues of indestructibility, homogeneity and high electrical efficiency. That means more satisfactory operation of motors with the Fairbanks-Morse Copperspun rotor.

ONLY COPPERSPUN ROTOR OFFERS THESE ADVANTAGES:

- ★ A truly one-piece indestructible copper rotor winding.
- ★ Withstands higher temperatures: (melting point 2,000° F. for Copper, 1,100° F. for Aluminum)
- ★ High electrical and thermal conductivity.
- ★ Dense, uniform grain structure.
- ★ Separately mounted fans: permitting complete overall machining, better quality control, better dynamic balance.

MORSE

REMEMBERING

THESE ARE YOUR FAIRBANKS-MORSE SALES CENTERS

ATLANTA 3, GEORGIA
760 Lee St., S. W.
AMhurst 7701

BALTIMORE 18, MD.
659 E. 25th St.
BElmont 5258

BIRMINGHAM 1, ALA.
626 N. Ninth St. Zone 4
3-6546

BOSTON 10, MASS.
178 Atlantic Avenue
LAfayette 3-3600

BUFFALO 3, N. Y.
33 Franklin St.
Lincoln 4210

CHARLOTTE 2, N. C.
Liberty Life Bldg.
Room 605
6-2893

CHICAGO 5, ILLINOIS
1550 S. State St.
HArrison 7-7100

CINCINNATI 2, OHIO
49 Central Avenue
MAin 3010

CLEVELAND 14, OHIO
3000 W. 117th St.
CLearwater 1-3300

COLUMBUS 8, OHIO
1034 Goodale Blvd.
WAlnut 8581

DALLAS 2, TEXAS
1713 N. Market Street
CEntral 4347

DENVER 2, COLO.
1500 17th Street
TAbor 6241

DES MOINES 17, IOWA
2017 Dean Avenue
6-1189

DETROIT 13, MICHIGAN
11110 East Warren Ave.
VAlley 1-7100

DULUTH 2, MINN.
Board of Trade Bldg.
2-7538

HOUSTON 13, TEXAS
5521 Navigation Blvd.
WAyside 2159—(LD 506)

INDIANAPOLIS 2, IND.
1499 N. Harding St.
FRanklin 3684
ATlantic 3092

JACKSONVILLE 6, FLA.
930 East Adams St.
5-6473

KANSAS CITY 7, MO.
1300 Liberty Street
Victor 6474

LOS ANGELES 11, CALIF.
4535 S. Soto Street
JEfferson 8151

LOUISVILLE 8, KY.
2008 So. Brook St.
CAlhoun 1469

MEMPHIS 7, TENN.
676 Jefferson Ave.
5-1614

MILWAUKEE 3, WIS.
404 N. Plankinton
DAly 8-0180

MINNEAPOLIS 15, MINN.
417 S. Fourth Street
MAin 4353

NEW ORLEANS 13, LA.
1000 St. Charles Ave.
RAymond 3115

NEW YORK 4, N. Y.
80 Broad St.
HAnover 2-7470

OMAHA 8, NEBRASKA
902 Harney St.
ATlantic 3122

PHILADELPHIA 8, PA.
401 N. Broad St.
WA 2-4100

PITTSBURGH 24, PA.
4301 Main Street
SCheniey 1-3123

PORTLAND 14, OREGON
105 S. E. Taylor St.
EAst 0131

PROVIDENCE 3, R. I.
187 Pine Street
GAspee 1-1531

ST. LOUIS 2, MO.
217 South Eighth St.
CHestnut 7483

ST. PAUL 1, MINN.
220-26 E. Fifth Street
GArfield 4335

SALT LAKE CITY 1, UTAH
153 W. Second South St.
3-2108 & 3-5139

SAN FRANCISCO 7, CALIF.
630 Third Street
EXbrook 2-5855

SEATTLE 99, WASH.
Salmon Bay Terminal
ALden 6600

STUTTGART, ARK.
403 South Main St.
185

TULSA 3, OKLA.
1335 Hunt Bldg.
3-8231

WASHINGTON 5, D. C.
1000 Vermont Ave., N. W.
District 6694

FAIRBANKS-MORSE de MEXICO S. A.
Balderas 146, Mexico 1, D. F. Mexico
10 06 74 y 10 09 58

Export Division:
NEW YORK 4, N. Y.
80 Broad Street—HAnover 2-7470

Yours

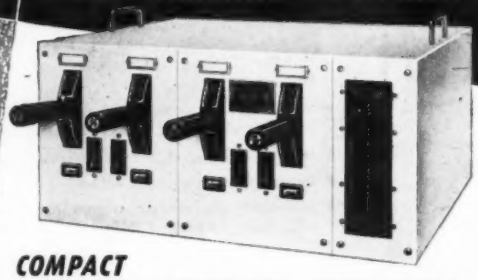
A NEW LINE

OF

PACKAGED

POWERSTAT

LIGHT DIMMING EQUIPMENT



COMPACT
PACKAGED ASSEMBLIES WITH COMPLETE FACILITIES FOR DIMMING, BRIGHTENING, BLENDING LIGHT

The popular economy line of **PACKAGED POWERSTAT** *light dimming equipment has been redesigned and a variety of new models offered. Assemblies of the 2000 watt series are now available in packages of 3, 4, 5 and 6 unit dimmers.*

Each packaged assembly is housed in an attractive smooth grey finished cabinet. Individual dimmers are operated by vertical hand levers with graduated drums. The levers can be interlocked for master control and when required a separate master handle can be provided. Each dimmer has its own on-off switch and circuit-breaker, card holder for circuit identifications and pilot light. These dimmers can be operated from a two wire — one phase, a three wire — one phase or a four wire — three phase a-c power source. Standard output connectors include a terminal board for solid connection, pin-jacks, parallel-blade receptacles and twist-lock receptacles. Send for Bulletin D651P to learn more about PACKAGED POWERSTAT light dimming equipment.

PACKAGED POWERSTAT DIMMERS IDEAL FOR SCHOOLS, CHURCHES, LODGES, HOTELS, RESTAURANTS, STORES, LOUNGES & CLUBS. WRITE FOR DESCRIPTIVE BULLETIN TODAY

THE SUPERIOR ELECTRIC CO. SE CO
BRISTOL, CONNECTICUT

6071 DEMERS AVE., BRISTOL, CONNECTICUT

☐ Please send me Bulletin D651P

NAME_____

COMPANY_____

CO. ADDRESS_____

CITY_____ ZONE_____ STATE_____

DID YOU KNOW THAT...

In 1950 Electrical Construction and Maintenance published 54 pages of feature articles on lighting?

And that isn't all!

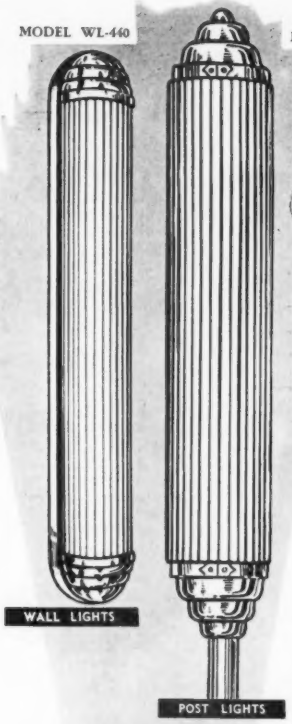
In 1950 Electrical Construction and Maintenance carried more lighting display advertising than any other publication in the field —260 pages to be exact.

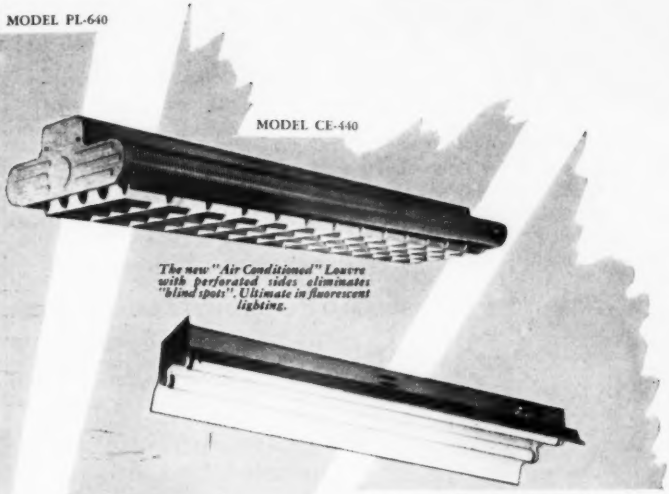
CONCLUSION:

For authoritative coverage of lighting . . . articles on design, application, installation and maintenance . . . and for the most complete display of lighting equipment advertising, read every issue of Electrical Construction and Maintenance.

IMPORTANT:

The annual lighting issue will be published in October.




MODEL CE-440
The new "Air Conditioned" Louvre with perforated sides eliminates "blind spots". Ultimate in fluorescent lighting.
2-3-4 Lite Industrials are U. L. Approved
MODEL IT-240

··cast a new light on PROFITS with GREAT NORTHERN Illumination

Great Northern Fixtures adequately meet the new standards in illumination

Great Northern manufactures a complete line of Fluorescent and Slim Line Fixtures for Industrial and Commercial Installations which creates a finely engineered line of fixtures that will meet any installation problem. These fixtures are precision products and are designed for easy installation and maintenance. We are geared to meet the new Frontiers of Lighting Progress in the 50's.

Brilliant outdoor fluorescents for • service stations • used car lots • outdoor theatres • night clubs • tourist courts • restaurants • highways • hotels • stop-and-socks • department stores • drive-ins • commercial building entrances and many other installations.

- U-L approved
- 1/3 cost of incandescent lighting
- 67% more light (actual test)
- visible at longer distances
- penetrates fog and haze
- weatherproof construction
- easy to install and maintain
- hinged glass door for easy accessibility
- operates efficiently below zero

WRITE for catalog illustrating our complete line of fixtures ECM-7

Distributed only through verified Electrical Wholesalers

•

wholesaler
contractor
architect
utility man

CREATED AND PRODUCED BY

HOUSED IN OUR MODERN BUILDING DEVOTED EXCLUSIVELY TO THE MANUFACTURE OF SUPERIOR FLUORESCENT FIXTURES.

GREAT NORTHERN MFG. CORP.

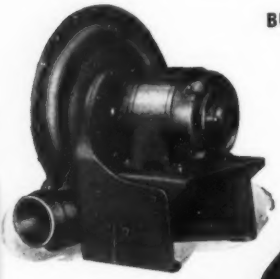
Fluorescent Fixture Manufacturers

4217-19-21 HARRISON ST. • CHICAGO 24, ILL.

Dept. 7-ECM

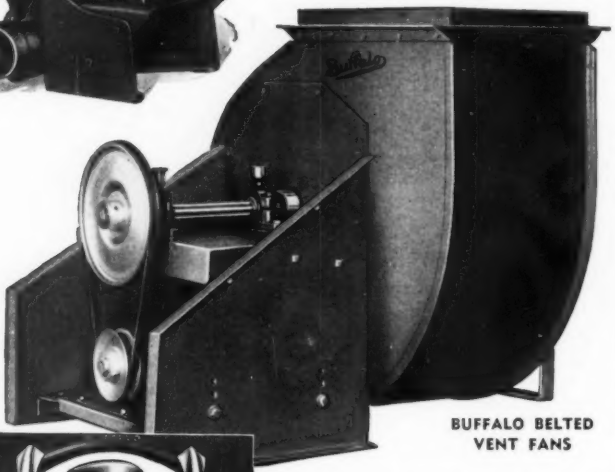
Practical Answer to many VENTILATING PROBLEMS

Many thousands of these "Buffalo" Fans now operating are doing a good job on ventilating service. Their quiet, low-maintenance performance and long life are continually adding to the "Buffalo" reputation for value. Shown here are three of our most-called-for fans. You'll want to get the facts on these profitable lines which meet many requirements.

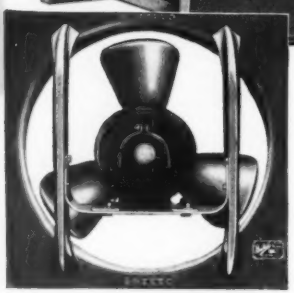


BUFFALO "E" BLOWERS-EXHAUSTERS

Husky, one-piece units for forge and furnace blowing, cleaning operations, cupola work. A number of these units often effect installation and power savings over one large fan, and permit flexibility of operation. WRITE FOR BULLETIN 3014-C.



BUFFALO BELTED VENT FANS



Here are light, compact, easily installed ventilation fans. They are non-overloading, and can be installed indoors or outdoors. Capacities are from 500 to 20,000 cfm at ¼" s.p. WRITE FOR BULLETIN 3720.

BUFFALO BREEZO FANS

So simple to install and service, these fans appeal to economy-minded firms! Of heavy-duty construction throughout, they have rigid die-stamped panel, arms and blades. Available in 6 sizes, 8" to 24". WRITE FOR BULLETIN 3222-F.

"Buffalo" First For Fans

BUFFALO FORGE COMPANY

520 BROADWAY BUFFALO, NEW YORK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

Branch Offices in All Principal Cities

PANEL BREEZO FANS BELTED VENT SETS BELT-AIR FANS

BREEZ-AIR ATTIC FANS "L" BREEZO FANS "NV" BREEZO FANS

QUALITY AT A PRICE

AFCO Lite WEATHERPROOF LAMP HOLDERS

Socket can be adjusted Streamlined Lightweight Compact Weatherproof with double-seal gaskets

YARDLIGHTS

—deep drawn metal reflector—no spilled light. 12" or 14" diameter. Porcelain socket for medium base lamps up to 200 watt. Durable baked enamel finish. Heavy cast aluminum fittings. Completely wired. Weatherproofed throughout.

AFCO FLUORESCENT FIXTURES

Residential
Commercial
Industrial

Styled for Beauty—Built for Durability—Engineered for Efficiency—Priced for Quick Sales.

No. LUA-440—a very attractive streamlined louvered fixture. Gracefully curved, ribbed plastic sides. High in lighting efficiency. Economically priced. Designed for surface or suspension mounting.

• *Some choice territories still available*

AMERICAN FLUORESCENT CORPORATION
AFCO Lite Corporation
1234 N. Paulina Street
Chicago 22, Illinois

JOB: T. W. Rogers Co., Lynn, Massachusetts.

ARCHITECT: H. E. Davidson & Son, Boston, Massachusetts.

LIGHTING ENGINEER: J. Robert Cornell, Lynn Gas & Electric Co., Lynn.

SUPPLIER: DesRoberts Electric Supply Co., Lynn.

FIXTURES: No. 3224 two lamp recessed fixtures, with diffusing glass, on 10' spacing.

INSTALLATION DATE: July, 1946.

INTENSITY: Average on counters — 38 Footcandles in service. Average throughout area — 31 Footcandles in service.

Can you guess the date of this lighting installation?

Don't feel too badly if you fail in this "guess-test." Not many would know that these modern-as-tomorrow LITECONTROL fixtures were installed in July, 1946 — *five years ago!*

As you can see, the years of continuous use in this up-to-date department store have exacted no toll — either in appearance or performance — from these clean-lined, functional No. 3224 Troffer Type Recessed Units.

What's more, in addition to the proven feature of dependable long life, this unit is outstanding for easy access and low maintenance cost.

On *your* next lighting job, prove for yourself — as so many others have profitably been doing for years — that it pays to save with LITECONTROL . . . in time, in efficiency, in money.

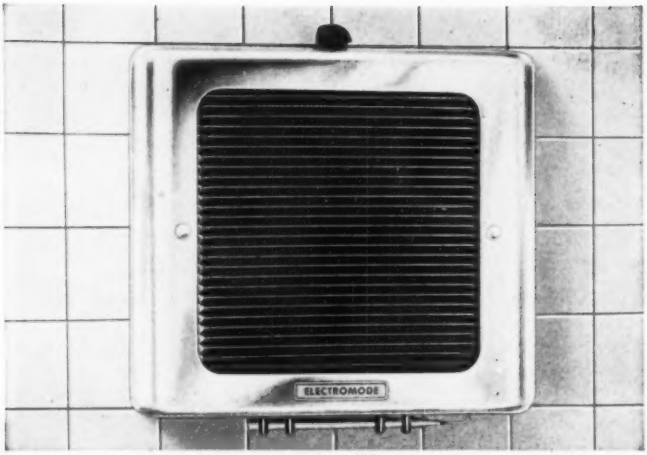
Call in your LITECONTROL Representative. No obligation, of course.

LITECONTROL *Fixtures*

KEEP UPKEEP DOWN

LITECONTROL CORPORATION, 36 Pleasant Street, Watertown 72, Massachusetts

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS



Model WJA-13 Electromode Automatic Bathroom Heater

Here's Your Answer to Year-Round Profit!

ELECTROMODE

ALL-ELECTRIC, AUTOMATIC BATHROOM HEATERS

YOU'RE missing a real opportunity if you're not selling and installing these much-wanted heaters. The market is unlimited. Every home —new or old—every cottage, auto court and camp is a prospect for one or more. And the selling season is all year 'round!

For auxiliary heating in any part of the country, or complete home heating in low-rate areas, Electromode Bathroom Heaters (and the Automatic Down-Flo Wall Heaters illustrated and described below) are perfect profit-makers. Mail the coupon below. We'll send you catalogs and full technical information.

Only ELECTROMODE Has All These Features

- Exclusive Cast Aluminum Lifetime Heating Element has no exposed wires—no danger of shock or burn.
- 100% Automatic Cut-Off Switch eliminates danger of fire.
- Automatic Room Temperature Control.
- Delivers 80 cubic feet of fan-circulated heat every minute.
- Operates for as little as 1c an hour.
- 1320 watts (on 110 volt AC).
- Fits compactly into the wall.
- As easy to install as an outlet.
- Quiet, long-life motor.
- Two finishes: white or chrome.
- Heating element guaranteed a lifetime.
- Approved by Underwriters' Laboratories.

AUTOMATIC DOWN-FLO WALL MODELS

Perfect for general room heating where heat is required quickly, at lowest possible cost, without plumbing or ductwork or disturbing the existing heating system. Built-in thermostat control. Range: 55° to 85° F. Fan circulates warm air at floor level. Capacities: 1500, 2000, 3000 and 4000 watts. Also available in non-automatic models. Front plate 17" wide, 21" high. Wall box is $4\frac{3}{32}$" deep and fits between standard studding.

ELECTROMODE All-Electric **HEATERS**

FREE CATALOGS!

ELECTROMODE CORPORATION, DEPT. EC-71
45 Crouch St., Rochester 3, N. Y.

Please send domestic and industrial heater catalogs together with full technical information.

NAME _____
TITLE _____
ADDRESS _____
YOUR WHOLESALER _____

KAYLINE
the one source lighting line

IT'S EASY TO SELL . . .

. . . from a copy of Kayline's new catalog #50 . . . because in it you'll find a complete selection of the finest modern lighting fixtures available. Whether it be incandescent or fluorescent . . . slimline, residential, industrial or commercial lighting, Kayline offers the very best in modern lighting fixtures. Write on your business letterhead for your copy.

See Sweet's Architectural File Section 31A-12

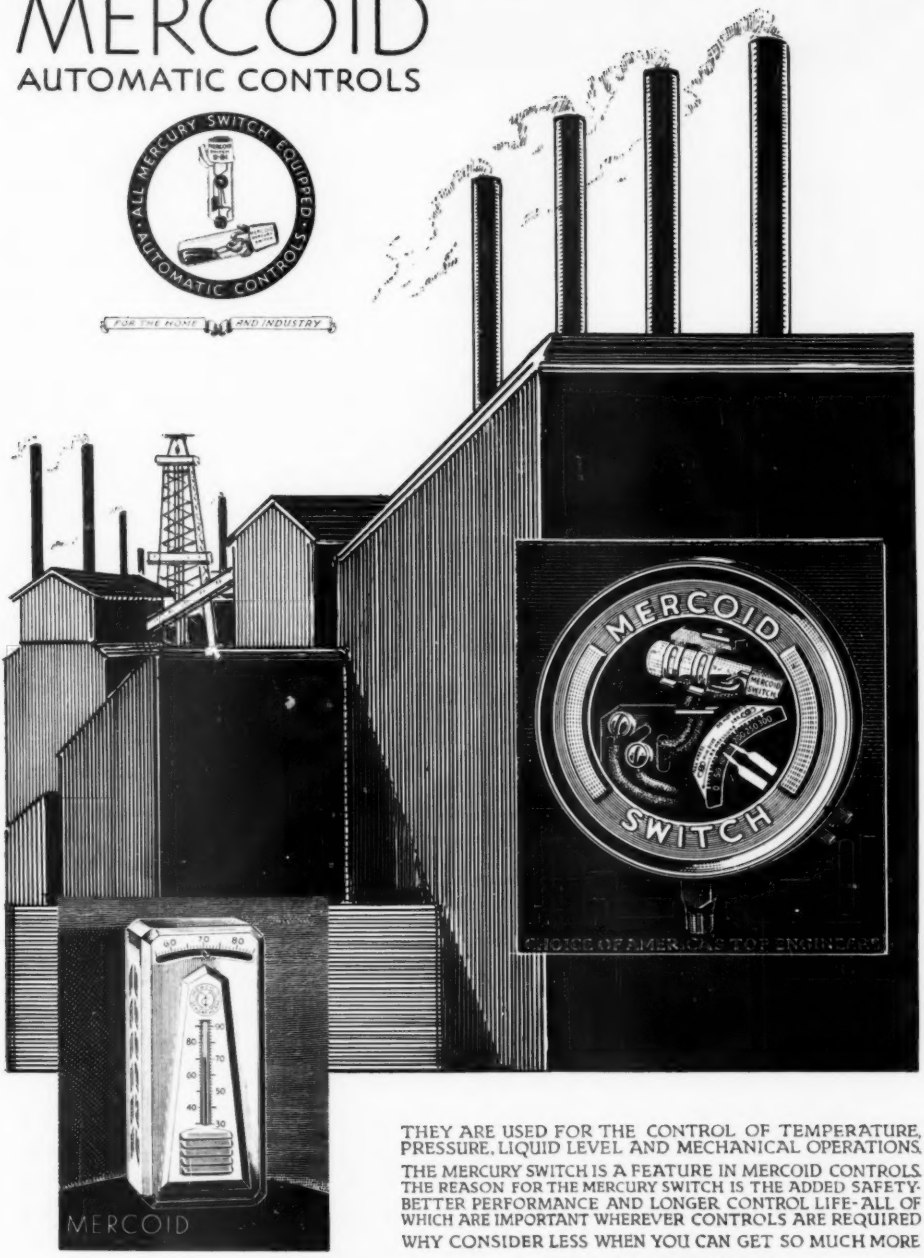
THE KAYLINE CO.
2480 East 22nd St.
Cleveland, Ohio

KAYLINE
the one source lighting line

MERCOID
AUTOMATIC CONTROLS

ALL MERCURY SWITCH EQUIPPED AUTOMATIC CONTROLS

FOR THE HOME AND INDUSTRY



THEY ARE USED FOR THE CONTROL OF TEMPERATURE, PRESSURE, LIQUID LEVEL AND MECHANICAL OPERATIONS.

THE MERCURY SWITCH IS A FEATURE IN MERCOID CONTROLS. THE REASON FOR THE MERCURY SWITCH IS THE ADDED SAFETY-BETTER PERFORMANCE AND LONGER CONTROL LIFE-ALL OF WHICH ARE IMPORTANT WHEREVER CONTROLS ARE REQUIRED

WHY CONSIDER LESS WHEN YOU CAN GET SO MUCH MORE

WRITE FOR COMPLETE CATALOG

THE MERCOID CORPORATION ▷ 4201 BELMONT AVE., CHICAGO 41, ILL.

Builders' Favorites

FASCO

CEIL-N-WALL FAN for ceilings and inside walls

FASCO

THRU-THE-WALL fan for any outside wall

FASCO

KITCHEN VENTILATING FANS

More builders choose FASCO, and here's why:

- **EASY INSTALLATION**—"CEIL-N-WALL" model fits standard duct perfectly. "Thru-the-Wall" models have adjustable sleeves, fit any wall thickness.
- **ECONOMY**—Low in first cost, inexpensive to install, thrifty in current consumption.
- **DEPENDABILITY**—Built of finest materials for long life . . . effective, quiet performance with little care required.
- **BUYER APPEAL**—Handsome styling and beautiful finish. Fully automatic operation.

A FASCO-ventilated kitchen is modern, clean, comfortable. That means a cleaner, better home . . . a better value.

No other low-cost "extra" adds so much sales appeal.

Write or wire today for Bulletin EC-15.

formerly F. A. SMITH MFG. CO., INC.

FASCO Industries, Inc.

ROCHESTER 2, N. Y., U. S. A.

DID YOU KNOW THAT...

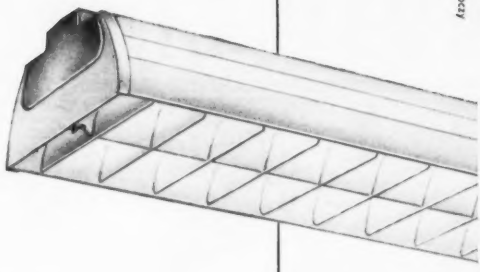
In 1950 Electrical Construction and Maintenance published 13 articles on estimating? Basic stuff this estimating, very often it draws the line between profit and loss. By popular request last year's articles will be consolidated in one reprint. These reprints will become available shortly.

During 1951 you'll find articles on estimating in just about every issue. Read them carefully and put them to profitable use in your business.

• • •

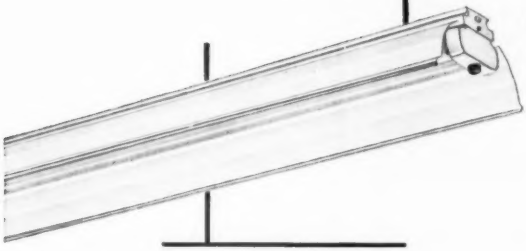
In 1950 Electrical Construction and Maintenance published 27 articles on industrial and commercial wiring and equipment installation?

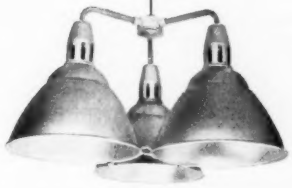
Again during 1951 devoted attention will be given to wiring. For new techniques...time and cost saving methods . . . be sure to read these articles.



Nordin & Radoczy

ELEMENTS TO LOOK FOR IN MEASURING LIGHTING FIXTURE VALUES





First and foremost, **QUALITY** of equipment to assure good lighting performance and long service.

Then, engineering features that simplify installation and keep down to a minimum the cost of maintenance.

And—important economic consideration—low overall cost (cost of equipment, installation and maintenance).

These constitute **VALUE**—lighting satisfaction.

You'll find all these elements in Miller lighting equipment—Fluorescent, Incandescent, and Mercury-vapor—built on an 8-Point **QUALITY** standard, on a background of 107 years' pioneering and progress in **GOOD LIGHTING**.

Proven by thousands of installations in stores, offices, schools, factories and public buildings, covering a wide range of lighting requirements.

Light with confidence the *proven* Miller way. Miller field engineers and distributors are conveniently located for nation-wide service.

THE miller COMPANY MERIDEN, CONN.
SINCE 1844

ILLUMINATING DIVISION: Fluorescent, Incandescent, Mercury Lighting Equipment
HEATING PRODUCTS DIVISION: Domestic Oil Burners and Liquid Fuel Devices
ROLLING MILL DIVISION: Phosphor Bronze and Brass in Sheets, Strips and Rolls

GOOD LIGHTING

15% of all INDUSTRIAL ACCIDENTS can be traced to IMPROPER LIGHTING!

The formula for Good Lighting is the combination of proper equipment and simple methods of maintenance. The Abolite Duo-Move System encourages regular cleaning habits because Duo-Move units can be cleaned and relamped quickly and safely without using clumsy ladders. Merely a twist of the wrist—reflector and lamp assembly can be removed and serviced—another turn and it's back in position . . . no interruption to workers . . . no lost time. The Abolite Duo-Move System guarantees maximum illumination with minimum service expense. Write for the Duo-Move story today!

THE JONES METAL PRODUCTS CO.,
West Lafayette, O.

WHITER THAN WHITE
ABOLITE Lighting

FOR THE RECORD

Did you know that this issue, with more than 100 pages of editorial material, packed full of forward-looking technical information and profit-building ideas, is the equivalent of a 400 page textbook?

Did you know that 229 advertisers have used this issue to bring you the latest information about products and services that will help you to do a better job . . . more efficiently . . . more profitably?

This issue is an outstanding example of America's industrial inter-communication system at work: editors and manufacturers working together, promoting the exchange of ideas, to keep you well informed and in step with the rapid cadence of electrical progress.

ELECTRICAL CONSTRUCTION AND MAINTENANCE

NEW!

MITCHELL DYNALITE

JOB-RATED LIGHTING FOR AMERICAN INDUSTRY

NOW—MITCHELL introduces the first Job-Rated lighting line designed to the specifications of American industry. "*Dynalite*" offers 82 high-efficiency units in an unprecedented range of types for *proper* lighting in every working area. Featuring exclusive new advantages, "*Dynalite*" makes possible simplified planning and installation of lighting rated to provide maximum efficiency in any industrial application.

THE COMPLETE, UNIFORM, IN-STOCK INDUSTRIAL LIGHTING LINE

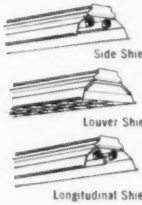
6 LAMP TYPES & SIZES

T-12 40-watt 48" bi-pin
T-17 40-watt 60" Low-Brightness mogul bi-pin
T-17 40-watt 60" Low-Brightness single pin
T-17 85-watt 60" Krypton mogul bi-pin
T-12 40-watt 48" 430 ma. Slimline
T-12 75-watt 96" 430 ma. Slimline

4 LAMPHOLDER TYPES

Medium Bi-Pin
Push Type Single Pin
Mogul Bi-Pin
Turret Type Bi-Pin

3 SHIELDING TYPES



Side Shielded
Louver Shielded
Longitudinal Shielded

2 REFLECTOR TYPES

MITCHELL Baked Enamel
RLM Porcelain Enamel

MULTI-CHANNEL TYPES—*THE RIGHT UNIT FOR EVERY JOB*

Available in 4, 5, 8 and 10 foot lengths . . . single, tandem and combination types . . . 2, 3 and 4 lamp units. Continuous uniform wireway channel makes it easy to plan any installation *light-rated to the job.* There's nothing like "*Dynalite*" for limitless flexibility, economy, quality and dependability.

Send for it **"DYNALITE" CATALOG**

See how MITCHELL "*Dynalite*" custom-fits any industrial lighting job. Have the complete technical data that makes it easy to specify *correct* industrial lighting. You'll want a FREE copy of the complete "*Dynalite*" Catalog packed with descriptive details. Write for it today.

MITCHELL MANUFACTURING COMPANY
2525 N. CLYBOURN AVE., CHICAGO 14, ILLINOIS
In Canada: **Mitchell Mfg. Co., Ltd., 11-25 Davies Ave., Toronto**

MITCHELL MANUFACTURING COMPANY
2525 N. Clybourn Ave., Chicago 14, Illinois

☐ Send Free descriptive catalog on MITCHELL "*Dynalite*" Job-Rated Industrial Lighting.

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*Firm Name*_____

*Address*_____

*City*_____ *Zone*____ *State*_____

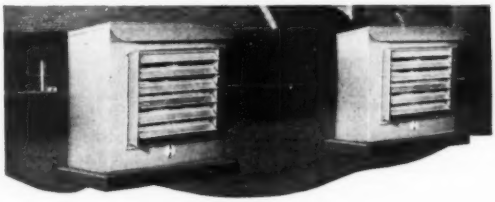
EFFECTIVE VENTILATION

with

Peerless Electric

PENTHOUSES AND FANS

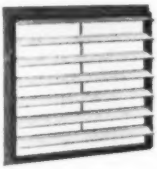
Peerless Electric penthouses provide ideal ventilation for factories, laundries, stores, auditoriums and similar buildings.



Economical Weathertight AUTOMATIC SHUTTERS

Eight Sizes
12" to 48"

Peerless Electric fans can be furnished for all sizes of these penthouses.



Automatic Shutters
Aluminum Louvers
Quiet
Counterbalanced

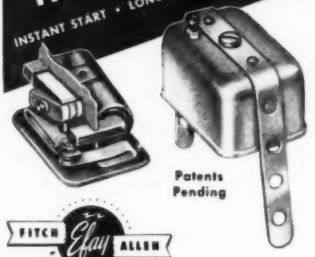
Ceiling Shutters in five square sizes
Wall Shutters in nine square sizes

Write for complete specifications on Peerless Electric penthouses, shutters and ventilating fans.

THE PEERLESS ELECTRIC COMPANY
Established 1893 • WARREN, OHIO

Peerless Electric
MOTORS • FANS • BLOWERS

THE *Efay*
MOTOR STARTING SWITCH
FITS ALL MOTORS!
INSTANT START • LONG LIFE • DEPENDABILITY



Patents Pending

FITCH *Efay* ALLEN

For Single Phase, Split Phase, or Capacitor Fractional hp Single or Dual Voltage Motors

From 1/6 to 1/3 hp incl., 50/60 cycles

Write to Dept. E for Information and Prices

FITCH, ALLEN AND COMPANY
9306 WEST BELMONT AVENUE
FRANKLIN PARK, ILLINOIS

Profits Everywhere!
with **TORKMASTER**
UTILITY TIME SWITCH

When selecting automatic time switches for indoor and outdoor uses remember the advantages of dependable TORK CLOCKS. Ideal for — Signs and Window Lights — Pumping — Defrosting — Oil Burners — Pre-heating — Lead or Wax — Hen house lights. Write today for complete details.

No. 948A $11.00 List
30 AMP • SINGLE POLE
TELECHRON MOTORED

America's Biggest Time Switch Value

TORK CLOCK CO. INC.
ONE GROVE STREET • MOUNT VERNON • N. Y.

PEMCO

LIGHTS THE WAY

With This Quality Line of Luminaires

Modern lighting makes the difference . . . and whether it is Street Lighting, Flood or Spot Lights, PEMCO Products are way ahead on four major points: Quality, modern design, distinctive finish and economy.

Illustrated are a few of the wide range of PEMCO products. Backed by 69 years of Street Lighting Manufacturing and "know-how," PEMCO today is a leader in the field.

Union Metal Poles—Easy to install, require little maintenance. Available with PEMCO Luminaires, making an ideal combination and complete package.

PEMCO-SYLVANIA—Unique in that lamp and reflector are one unit. Low maintenance expense. A new reflector is supplied intact with each new lamp.

PEMCO Modern Alzak Street and Highway Luminaires—for multiple or series circuits up to 5000 volts. For internal or external wiring.

PEMCO SERVICE STATION LIGHTING—Ruggedly constructed Island Luminaire available with from one to five Flood or Spot Lights mounted on top.

STREET LIGHTING LUMINAIRES—with deep asymmetric aluminum reflector. One of many styles. Aluminum hood tapped 1-¼".

PEMCO FLOODLIGHTS—Aluminum with PEMCO "Aluminous Process" 18" dia. reflector. Clear, heat-resisting glass lens.

PEMCO FLOOD OR SPOT LIGHTING—Using PAR-38 or R-40 Reflector Flood Lamps. Cover plate for 4" conduit outlet box, or for wall mounting. Red, Green, Blue or special colors.

Catalog #90 will give you full details and specifications covering PEMCO's complete line of lighting fixtures, as well as engineering tips. To obtain your copy, attach coupon to your business letterhead and mail today.

PHILADELPHIA ELECTRICAL & MFG. CO.
1200-36 N. 31st St., Phila. 21, Pa.

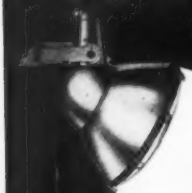
Please send copy of PEMCO General Catalog No. 90 to:

NAME .....

POSITION .....

PHILADELPHIA ELECTRICAL & MANUFACTURING CO.
1200-36 N. 31st Street, Philadelphia 21, Pa.
Sales Offices in Principal Cities

FOR BETTER PLANT SAFETY LIGHTING



VERSATILE STEBER LIGHTING UNITS

MEET EVERY LIGHTING REQUIREMENT

Steberlites for PAR-38 and R-40 Lamps.

STEBERLITE
Spot and Floodlights

Steberlites are cast aluminum, weatherproof, completely wired, articulated units made for both medium and Mogul base lamps. They can be mounted on walls, poles, or directly to outlet boxes, either singly or in clusters up to 6. Because of their flexibility, easy installation, and long life, Steberlites are the logical, economical answer to hundreds of lighting problems. It will pay you to investigate Steberlites. Write for Bulletin 120 today.

No. 57

No. 1600

Series "4000"

STEBER FLOODLIGHTS FOR EFFICIENT AREA ILLUMINATION

Steber floodlights are especially adapted to safety lighting. They are easy to install and maintain, compact, flexible, rugged, weatherproof, and completely wired.

For small areas, open types No. 57 and 59 (100-300 watts), and enclosed types No. 572 and 592 (100-200 watts) are particularly suited. For larger areas and for lighting entrances, building fronts, etc., No. 1600 enclosed Floodlight with spun aluminum reflector is ideal. Uses 300-500 watt Mogul base lamps.

Series 4000 Aluminum Floodlight is designed for the efficient, economical illumination of all large areas including recreation fields, protective lighting of industrial plants, railroad yards, for lighting night construction projects, or for high intensity illumination in any application. Furnished in open or enclosed types, diffuse or specular alzak, with all standard mounting brackets. 750-1500 watts. Write for Bulletins 127-50 and 128-50.

Sold through Leading Wholesalers *Underwriters' Laboratories Approved*

STEBER

STEBER MANUFACTURING CO.
Dept. 98, Broadview (Maywood P. O.), Illinois

DID YOU KNOW THAT...

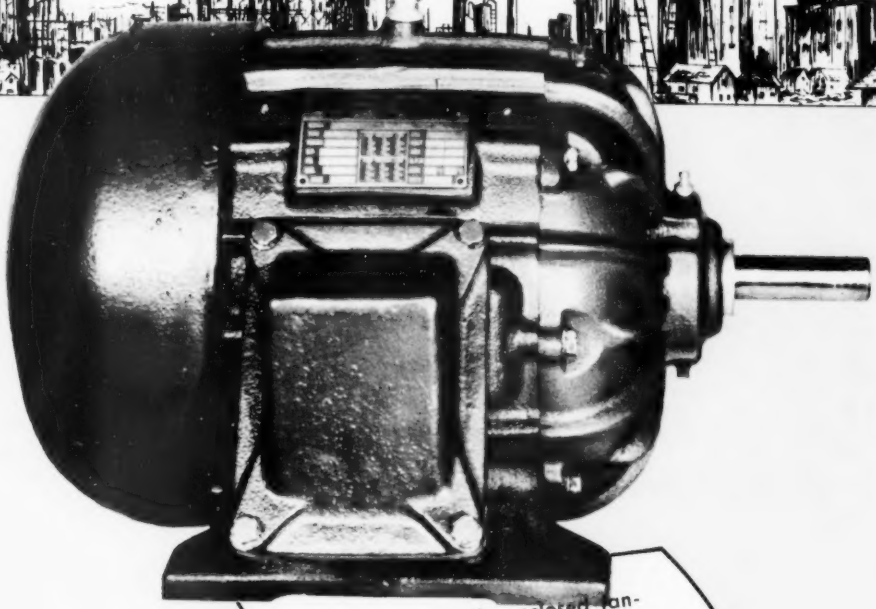
Electrical Construction and Maintenance has a special department to handle your requests for technical and product information. It's properly entitled "READER SERVICE." Acquaint yourself with this department and the valuable service it offers. Properly used it can save you endless time. And today, time is money.

• • •

"Washington Report" is another special monthly editorial feature. It gives you an up-to-the-minute, authoritative picture of government happenings that will influence your business. Written by Berlon Cooper our Eastern Editor . . . who is also a special consultant to the National Production Administration . . . it is "must reading" for all electrical men who plan ahead.

MARATHON

EXPLOSION PROOF MOTORS FOR HAZARDOUS LOCATIONS . . .



Marathon's totally enclosed fan-cooled explosion-proof motors assure the quality and safety margins required for your machines operating in hazardous locations. Approved by Underwriters' Laboratories for your further insurance.

Supplied in NEMA frames 56 through 505. All fractional horsepower ratings; single phase to 5 HP; polyphase induction to 150 HP.

MARATHON ELECTRIC MANUFACTURING CORP.

WAUSAU • WISCONSIN

SB-132

Some facts about MARATHON *EXPLOSION-PROOF* motors . . .

NEMA defines . . .

EXPLOSION-PROOF MACHINE: a totally-enclosed machine designed and built to withstand an explosion of gas or vapor within it and to prevent ignition of gas or vapor surrounding machine by sparks, flashes, or explosions which may occur within machine casing. (MG1-1.14)

DUST-EXPLOSION-PROOF MACHINE: a totally-enclosed machine designed and built so as not to cause ignition or explosion of an ambient atmosphere of dust and also not to cause ignition of dust on or around machine. (MG1-1.14)

NATIONAL ELECTRICAL CODE defines . . .

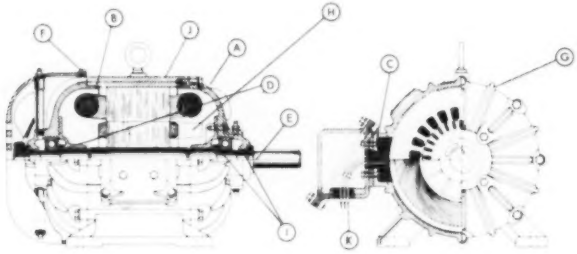
HAZARDOUS ATMOSPHERES:

Class I - Group A -	Atmospheres containing acetylene
Class I - Group B -	Atmospheres containing hydrogen or gases or vapors of equivalent hazard such as manufactured gas
Class I - Group C -	Atmospheres containing ethyl ether vapor
Class I - Group D -	Atmospheres containing gasoline, petroleum, naptha, alcohols, acetone, lacquer, solvent vapors and natural gas
Class II - Group E -	Atmospheres containing metal dust
Class II - Group F -	Atmospheres containing carbon black, coal or coke dust
Class II - Group G -	Atmospheres containing grain dust

Marathon Electric motors designed for checked atmospheres.

MARATHON ELECTRIC produces . . .

EXPLOSION PROOF MOTORS around the above definitions and according to further specifications set up by NEMA & The National Board of Fire Underwriters. Some of the outstanding features of engineering design are shown below.



(A) Brackets and frame made of cast iron of extra thickness to withstand explosions within and corrosion throughout.

(B) Long rabbet on brackets gives extra long flame path.

(C) Leads sealed in compound having strength, high dielectric, and moisture resistance.

(D) Internal slinger designed to lengthen gaseous flame path.

(E) Slingers on shaft backed up with annular grooves keep foreign material from entering motor along shaft.

(F) Air taken in by external fan is accurately jetted over the outer surface of the motor to provide continual cooling and cleaning.

(G) Ribbed exterior increases surface area for greater cooling.

(H) Internal circulation provided by rotor fan and carefully designed air passages to prevent local hot spots.

(I) Ample grease capacity in the proper location for lubrication of bearings.

(J) Single wall design eliminates dirt pockets and provides simplicity in cleaning.

(K) Conduit box design gives ample room for connecting. Box can be turned to four positions and can be mounted on either side of motor.

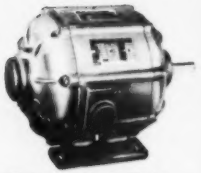
Interchangeable parts used throughout for efficient servicing.

INDUSTRY uses . . .

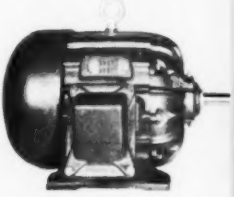
EXPLOSION PROOF motors wherever explosive atmospheres or corrosive elements prevail. The chemical, abrasive, petroleum, mining, paint, flour, and grain processing industries are a few of the many users.

MARATHON ELECTRIC MANUFACTURING CORP.

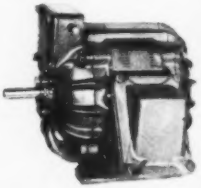
Home Office — Wausau, Wisconsin — District Offices in principal cities



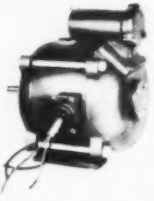
NEMA 66 FRAME SERIES — NON-VENTILATED EXPLOSION PROOF — POLYPHASE INDUCTION MOTOR — TYPICAL OF 1/2 AND 3/4 HP RATINGS.



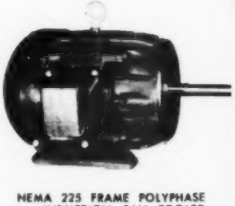
NEMA FRAME 254 — POLYPHASE INDUCTION FAN-COOLED — EXPLOSION PROOF MOTOR — TYPICAL OF RATINGS IN NEMA — FRAMES 224 THROUGH 505.



NEMA FRAME 203 — POLYPHASE INDUCTION NON-VENTILATED — EXPLOSION PROOF MOTOR — WITH BUILT IN "ON-OFF" SWITCH.



CAPACITOR-START — SINGLE PHASE NON-VENTILATED EXPLOSION PROOF MOTOR — TYPICAL 1/2 AND 3/4 HP RATINGS.



NEMA 225 FRAME POLYPHASE — INDUCTION FAN COOLED EXPLOSION-PROOF MOTOR WITH "C" FACE MOUNTING FOR CLOSE COUPLED PUMP.

QUAD LIGHTING

MODERN UNITS *for America's New* LIGHTING PROGRAMS

GYMNASIUM LIGHTING UNITS

SPADE SIGN REFLECTOR

ROUND ANGLE SIGN REFLECTOR

RECTANGULAR SIGN REFLECTOR

POST TOP OR PUMP ISLAND REFLECTOR

RLM Angle

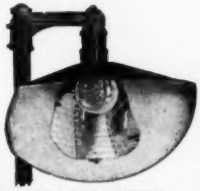
RLM Glassteel Diffusers

RLM Standard Bowl

RLM Deep Bowl

THREE LIGHT FLOODLIGHT WITH MEDIUM BEAM

AISLE STOCK REFLECTOR



ONE LIGHT MEDIUM BEAM FLOODLIGHT

TWO LIGHT MEDIUM BEAM FLOODLIGHT

You Contractors across the country who have in the past and will in the years to follow, shoulder much of the responsibility for progress in the field of lighting, are certainly in line for congratulations for your good work.

We have continued through the past 30 years to design and make lighting units best fitted for their individual applications and therefore to make each of your installations outstanding achievements.

Good luck in all of your endeavors and may you prosper as America continues to roll onward to New Frontiers.

QUADRANGLE MFG. CO.

325 S. PEORIA ST. CHICAGO 7, ILL.

HYDEE HANGER*

REDUCES INSTALLATION TIME

EASY, LOW-COST WAY TO HANG CHAIN-SUSPENDED FIXTURES

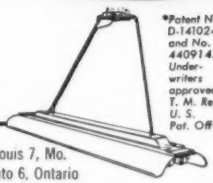
"DECIDEDLY BETTER"
DAY-BRITE *Lighting Fixtures*

1. Connect wires to receptacle. Fits standard 4" or 3¼" outlet box or plaster ring.

2. Screw hanger to outlet box—only two screws needed. No centering, no punching, no drilling. Screwdriver only tool needed.

3. Hang the fixture and plug it in. That's all! Self-grounding—regular 2-wire cord and plug may be used.

Hydee Hanger, complete with receptacle, two 5-ft. chains, "S" hooks and clips—



*Patent No. D-141024 and No. 440914. Underwriters approved. T. M. Reg. U. S. Pat. Off.

Day-Brite Lighting, Inc., 5402 Bulwer Ave., St. Louis 7, Mo.
In Canada: Amalgamated Elec. Corp., Ltd., Toronto 6, Ontario

02

DISTRIBUTED NATIONALLY BY LEADING ELECTRICAL WHOLESALERS

FRIGID Fans
FOR peak performance, maximum efficiency AND ECONOMY
You can depend on Frigid Fans for the best in ventilation. A complete line including Attic Fans, Pedestal, Wall and Ceiling Fans, Electrically Reversible Window Fans, Hassock Fans, Blowers, Shutters, Exhaust Fans, etc.

Write for literature.

CIRCULATORS & DEVICES MFG. CORP.
128-168 THIRTY-SECOND STREET • BROOKLYN 32, N. Y.

DID YOU KNOW THAT...

In 1950 Electrical Construction and Maintenance published 54 pages of feature articles on lighting?

And that isn't all!

In 1950 Electrical Construction and Maintenance carried more lighting display advertising than any other publication in the field —260 pages to be exact.

CONCLUSION:

For authoritative coverage of lighting... articles on design, application, installation and maintenance... and for the most complete display of lighting equipment advertising, read every issue of Electrical Construction and Maintenance.

IMPORTANT:

The annual lighting issue will be published in October.

Sangamo

the Time Switch with the *Automatic Memory* will often help increase productivity in INDUSTRIAL PLANTS

Extra margin of dependability: **This "carryover" type of Sangamo Time Switch continues to operate—even during current interruptions. Requires no re-setting.**

Here is a typical application in industry: The motor on this automatic wheel fitter is cut in by a Sangamo Heavy Duty Time Switch before working hours, in order to permit parts to heat and expand to normal operating conditions.

There are many ways in which Sangamo Time Switches can help increase productivity in modern mechanized industry. For instance, they will eliminate "waiting" time on a number of applications (see list below), where heating is an essential part of a production process. In fact, *any* function which depends upon the opening or closing of electric contacts on a daily repetitive schedule will be performed unfailingly—at the exact time wanted, by the automatic memory of these switches. A few applications where Sangamo Time Switches can serve as tools of industry are suggested below.

INDUSTRIAL APPLICATIONS

For daily pre-heating:

Lead pots for solder operations.
Zinc for injection molding.
Type metal in type foundries.
Dies in plastic molding presses.
Glue in woodworking shops.
Tanks for galvanize dipping.
Electric ovens and furnaces.
Infra-red paint dryers.
Electronic testing equipment.
Soldering irons on assembly lines.

For daily circuit control:

Yard floodlights.
Runway and hall lights.
Electric factory signs.
Pumps, compressors.
Water softeners.
Mixing equipment.
Electric doors and gates.
Air conditioning.
Alarm systems.
Exhaust fans.
Electric valves.
Two-level thermostats.

SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

Get the full story—write for Catalog No. 1010-A today.

ST51-6

For unexcelled dependability and permanence

Specify and Install

AEMCo **TIME SWITCHES**

EQUIPPED WITH SYNCHRONOUS, SELF-STARTING MOTORS

A. C. OR D. C. OPEN OR CAN TYPE WITH TUBE-BASE PLUG-IN FEATURES

Highest quality material and unexcelled craftsmanship combine to make Automatic Time Switches the *preference of* those who demand *long life dependability backed by an unconditional guarantee.*

Compact, *carefully engineered* Automatic Time Switches have new type, easily set trip levers. Trip levers and dial are visible thru window in attractively finished, tamper-proof case.

Stock Models: Single Circuit, Single Pole, 10 Amperes Capacity to Two Circuit, Four Pole, 45 Amperes Per Pole Capacity. Special models engineered to your requirements.

AEMCo **RELAYS**

Automatic Electric Relays . . . Midget, Interlocking, Circuit Control, Latching, Adjustable . . . are built to exacting high standards to assure unexcelled dependability. Custom built relays designed to your specifications.

Accurately rated Automatic Electric Relays deliver "Diamond Quality" performance.

Write for complete specifications.

LOOK FOR THE DIAMOND SEAL FOR DIAMOND QUALITY

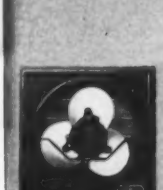
AEMCo *Automatic Electric* MFG. CO.

50 STATE STREET
MANKATO, MINNESOTA

Create more comfortable interiors with

Air King fans

Office, home, factory or store . . . proper ventilation enhances the value of any interior — makes it more comfortable, more enjoyable. Outstanding Air King Fans are handsomely styled, expertly engineered, economically priced. Send for free catalogue.



Built in
KITCHEN CEILING FAN

Removes smoke, odors, grease, etc. Easily adjusted to mount anywhere in the ceiling. Heavy guage all steel with gleaming white enamel or sparkling chrome grill. Quiet, powerful.

DELUXE EXHAUST FAN

Perfect for factories, warehouses, stores, etc. Rugged heavy gauge steel construction . . . exhausts against stronger wind pressure. Carefully balanced aluminum blade with self closing weatherproof aluminum louvers attached. In 12" to 24" models with 1 or 2 speeds.

WALL SWITCH CONTROLLER

No dangling chains!

Flick the wall switch and quiet, powerful kitchen fan starts or stops—outer door opens or closes. Easier to clean, longer lasting. All models adjust to fit 16" walls. Chrome or gleaming white enamel grill.

BERNS *Air King*

For Export, write to: AUTOMOTIVE DISTRIBUTORS, INC. [illegible] U. S. A.

BERNS MFG. CORP.
3050 No. Rockwell, Chicago 18, Ill.

DID YOU KNOW THAT...

In 1950 Electrical Construction and Maintenance published 13 articles on estimating? Basic stuff this estimating, very often it draws the line between profit and loss. By popular request last year's articles will be consolidated in one reprint. These reprints will become available shortly.

During 1951 you'll find articles on estimating in just about every issue. Read them carefully and put them to profitable use in your business.

• • •

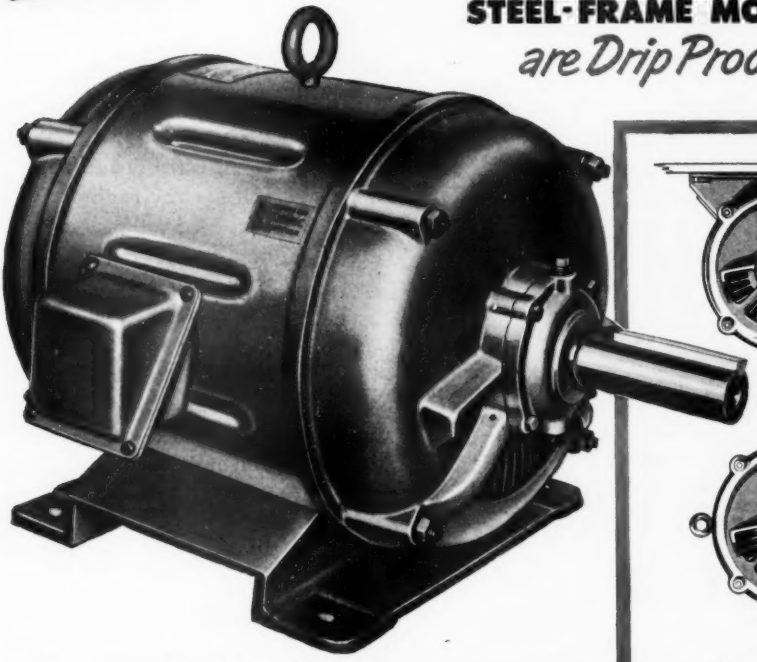
In 1950 Electrical Construction and Maintenance published 27 articles on industrial and commercial wiring and equipment installation?

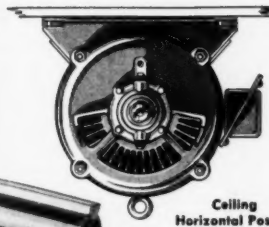
Again during 1951 devoted attention will be given to wiring. For new techniques...time and cost saving methods . . . be sure to read these articles.

Wagner
ELECTRIC MOTORS
...the choice of leaders in industry

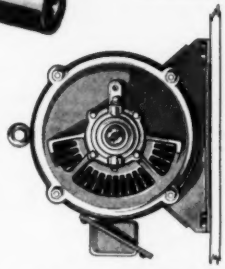
Ceiling Mounted-Sidewall Mounted
or in normal horizontal position

Wagner
STEEL-FRAME MOTORS
are Drip Proof

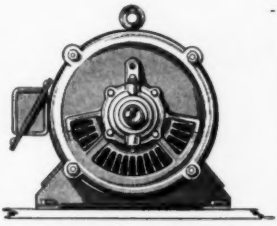




Ceiling
Horizontal Position



Sidewall Horizontal Position



Normal Horizontal Position

and...they're *proved* by years of service.

Here's an open-type general purpose motor that's completely drip-proof in any horizontal position, in frames 326 and smaller, because there are no openings in the frame and the endplates can be rotated 90° or 180° for drip-proof installation on walls or ceiling.

These steel-frame, squirrel-cage motors have been *proved*—for long, useful, troublefree life by more than twenty years of hard usage in many industries. Wagner steel-frame motors are available with either sleeve or *ball bearings which may be relubricated.* The motor frames are formed of heavy rolled steel, shaped to accurately center the stator core and to provide passages for ample ventilation. An internal fan moves a large volume of cooling air through these passages to carry off heat from all parts of the motor.

Wagner Steel-Frame Motors are available in electrical types to meet most industrial requirements.

Bulletins give full information on the complete line of Wagner Motors. Thirty-one branches, located in principal cities, are ready to assist you whenever you have a motor problem. In addition, almost 650 authorized motor repair shops provide speedy, nationwide service facilities.

Wagner
Electric Corporation
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WAGNER ELECTRIC CORPORATION
6413 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

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—FOR EVERY INDUSTRIAL AND COMMERCIAL REQUIREMENT!

Specifying Chelsea Fans for every installation is one sure way to proper ventilation. There's a Chelsea model for every requirement—industrial, commercial and residential—and each type is certified as to performance in accordance with the Standard Code of the Propeller Fan Manufacturers Assn.

← All-Purpose Fan Type BB

For removing smoke, steam, heat, fumes, etc. Heavy duty direct drive fan for continuous operation. Recommended for use against static pressure and in duct work. One piece panel and orifice, lightweight, simple to install. Sizes from 10" to 30". Totally enclosed motors.

Penthouse Ventilator Type PH

A complete ventilating system for roof installation, and adaptable to any air exhausting requirement. Easily installed, economical to operate. Fitted with automatic aluminum louvers. Fan sizes from 24" to 60". →

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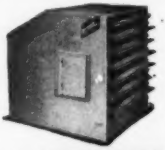
For large general area ventilation. Moves large volumes of air under pressure. Scientifically designed blades overcome high resistance in hoods and ducts. "V" belt drive. Sizes from 24" to 60".



SEND FOR YOUR FREE KIT! Contains all the information you need to make ventilating and cooling installations in factory, store, office or home. Write for complete information pertaining to your defense needs. Address inquiries to Dept. G.

CHELSEA FAN & BLOWER CO., INC.

General Offices and Plant: PLAINFIELD, NEW JERSEY

CHELSEA

THE *NEW* FLUORESCENT HORIZONTAL "T" LIGHT

ANOTHER GUARDIAN FIRST!

Model No. 570

The Newest, Finest Outdoor Fixture for Service Stations, Parking Areas, and All Other Applications Requiring Illumination of High Intensity Output with Low Surface Brightness.

FEATURES—

- Six 40-watt Instant Start Lamps
- High Power Factor Instant Start Ballasts
- Listed by Underwriters' Laboratories, Inc.
- Has Unique Air Cooling System to Dissipate Ballast Heat
- Spring Clips Provide Easy Access to Hinged Glass Frames—No Tools Needed
- Can be Mounted on Standard or Suspended under Canopy or from Bracket Arms
- Designed for Use with a Wide Variety of Cluster Light Combinations

Write Dept. E for New Free "T" LIGHT Bulletin

Guardian Light Company

301 LAKE STREET • OAK PARK, ILLINOIS

DID YOU KNOW THAT...

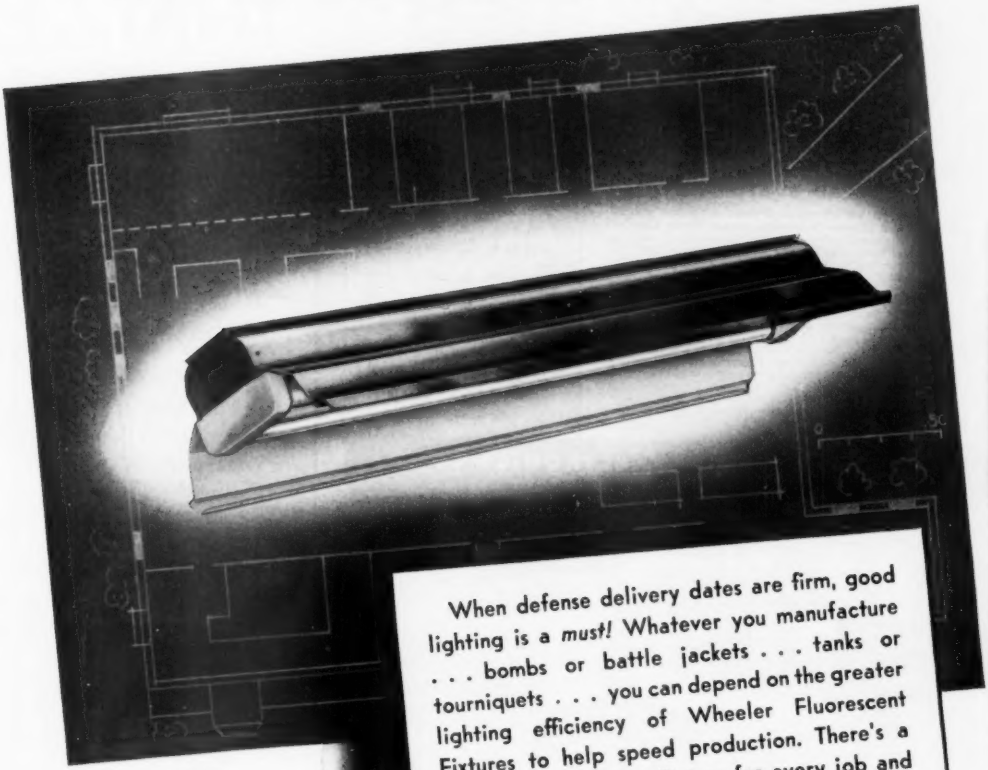
Electrical Construction and Maintenance has a special department to handle your requests for technical and product information. It's properly entitled "READER SERVICE." Acquaint yourself with this department and the valuable service it offers. Properly used it can save you endless time. And today, time is money.

• • •

"Washington Report" is another special monthly editorial feature. It gives you an up-to-the-minute, authoritative picture of government happenings that will influence your business. Written by Berlon Cooper our Eastern Editor . . . who is also a special consultant to the National Production Administration . . . it is "must reading" for all electrical men who plan ahead.

INCLUDE *Wheeler* **REFLECTORS**

IN YOUR **DEFENSE** PRODUCTION PLANS



There's a Wheeler Incandescent or Fluorescent Fixture to meet every industrial requirement.

When defense delivery dates are firm, good lighting is a *must!* Whatever you manufacture . . . bombs or battle jackets . . . tanks or tourniquets . . . you can depend on the greater lighting efficiency of Wheeler Fluorescent Fixtures to help speed production. There's a Wheeler Fluorescent Fixture for every job and every type of plant condition — Wheeler-engineered for ease of installation and proven maintenance savings. Get the complete story — write Wheeler Reflector Co.

275 Congress St., Boston 10, Mass.

Wheeler **REFLECTORS**

Distributed Exclusively Through Electrical Wholesalers

MADE BY SPECIALISTS IN "SKILLED LIGHTING" EQUIPMENT SINCE 1881

magno-tronic

DUAL SILVER POINT — FULLY AUTOMATIC

FLUORESCENT STARTERS

—completely eliminate annoying blinking and flickering of dead fluorescent lamps!

REFLECTS THE CRAFTSMANS SKILL

GUARANTEED — FOR ONE YEAR!

This is a glow switch condenserless precision starter equipped with automatic thermal relay circuit breaker. The relay automatically removes the lamp from the circuit electrically when the lamp becomes de-activated and automatically resets upon interruption of the lamp circuit.

SIMPLIFIES — Replacement of defective lamp automatically recycles starter circuit. No buttons to push — no replacement of starter.

REDUCES COST — Magno-Tronic starters provided exact timing of electrode heating, preventing excessive loss of emission material, thus assuring maximum possible lamp life.

VERSATILE — Built to operate efficiently over an extended voltage and temperature range.

SP-15-20 For use with 15 or 20 watt lamps.

SP-30-40 For use with 30 or 40 watt lamps.

SP-85-100 For use with 100 watt lamps.

Manufactured under U. S. PATENTS

2298236 2150837 2339307
2334935 2239244 2333694
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Other Patents Pending

INDUSTRIAL ELECTRONICS CORP.

General Offices & Main Plant, 80 BANK STREET, NEWARK 2, N. J.

JACKSON Quality PRODUCTS

1026 1214 1314

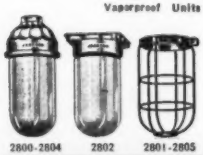
COMPLETE LIGHTING FOR INDUSTRIAL PLANTS • Farms and Rural Electrification

The Jackson line of lighting fixtures and Industrial Reflectors is a good, complete line. Jackson affords contractors a dependable source for quality and prompt service. Check into the line and see why it pays to be a Jackson contractor.

8972-8974-8978 Porcelain Enameled Yardlights

5200 5201 Weatherproof Sockets

Vaporproof Units



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SEND FOR CATALOG

Manufacturers of Reflectors Yard Lights Vapor proof units Weather proof Sockets

•

Sold only thru Distributors

JACKSON ELECTRICAL COMPANY

900-910 W. VAN BUREN STREET CHICAGO 7, ILLINOIS

DID YOU KNOW THAT...

In 1950 Electrical Construction and Maintenance published 54 pages of feature articles on lighting?

And that isn't all!

In 1950 Electrical Construction and Maintenance carried more lighting display advertising than any other publication in the field —260 pages to be exact.

CONCLUSION:

For authoritative coverage of lighting . . . articles on design, application, installation and maintenance . . . and for the most complete display of lighting equipment advertising, read every issue of Electrical Construction and Maintenance.

IMPORTANT:

The annual lighting issue will be published in October.

WILEY fluorescent fixtures

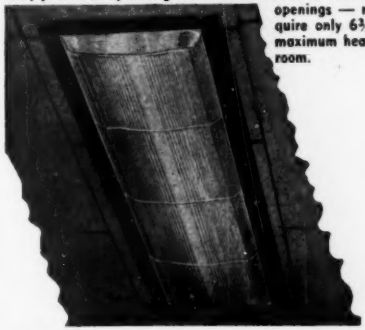
Commercial — Industrial — Special Purpose Lights
Fluorescent — Slimline

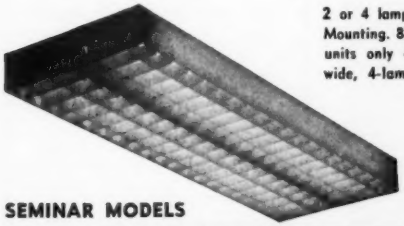
- Modern Designs—Low Installation Costs
- Custom Installations with Wiley Stock Units
- All Units have the E-Z Servicer (Pat. 2427084)
- All Models available in 24", 48", 72", and 96" lengths.
- Individual or continuous runs or combined with Wiley Spots.

Complete information—catalogs, prices will be sent on request. Write R. & W. Wiley, Inc., Dearborn and Bridge Sts., Buffalo 7, N. Y.

HALL-LITE—for corridors or "stack" lighting—where only lengthwise shielding is desired. Optional 20°, 30° or 45° shielding. Suspended or flush mounting.

RECESSED TROFFERS—2, 3, or 4 lamp. Open, louvered, Fleur-O-Guide (illustrated) Albalite, Twin lens, plastic or special glass enclosures. For 12" ceiling openings — require only 6¾" maximum headroom.





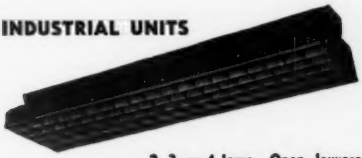
2 or 4 lamp—Suspended or Flush Mounting. 88% efficient. Louvered units only 4" deep; 2-lamp 12" wide, 4-lamp 18" wide; 35°-30° shielding; optional side panels; available with glass bottoms.

SEMINAR MODELS

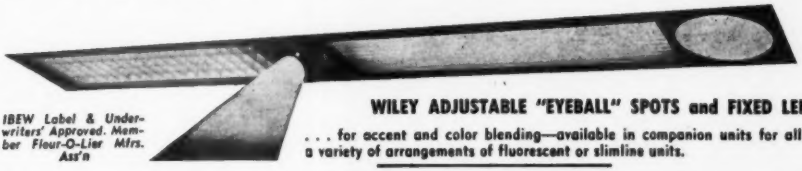
NIAGARA BEAM—Flush-to-ceiling Unit—2, 3 or 4-lamp. Louvered or glass bottoms. 6¼" deep x 13½" wide.

NIAGARA—2, 3 or 4-lamp—Suspended or Flush Mounting. Louvers or glass bottom—6" overall depth, 12" wide.

INDUSTRIAL UNITS



2, 3, or 4 lamp—Open, louvered or glass bottoms, for those who demand a high quality, durable installation.



IBEW Label & Underwriters' Approved. Member Fleur-O-Lier Mfrs. Ass'n

WILEY ADJUSTABLE "EYEBALL" SPOTS and FIXED LENS DOWNLITES

. . . for accent and color blending—available in companion units for all Wiley Models—permitting a variety of arrangements of fluorescent or slimline units.

R. & W. WILEY, INC., Dearborn and Bridge Sts., BUFFALO 7, N. Y.

A new home for the Magna-Lite line of Fluorescent & Slimline Luminaires

NOW! Double the floor space of our former plant, with completely integrated facilities.

NOW! Better and faster service than ever in filling orders through authorized wholesalers.

NOW! A line more comprehensive than ever, comprising both commercial and industrial fluorescent and slimline luminaires.

NOW! New equipment, better production—to make our quality and value even more outstanding.

METALCRAFT PRODUCTS CO., INC.

announces its removal to a new and larger plant at

MASCHER & LIPPINCOTT STS., PHILADELPHIA 33, PA.

FOR THE RECORD

Did you know that this issue, with more than 100 pages of editorial material, packed full of forward-looking technical information and profit-building ideas, is the equivalent of a 400 page textbook?

Did you know that 229 advertisers have used this issue to bring you the latest information about products and services that will help you to do a better job . . . more efficiently . . . more profitably?

This issue is an outstanding example of America's industrial inter-communication system at work: editors and manufacturers working together, promoting the exchange of ideas, to keep you well informed and in step with the rapid cadence of electrical progress.

ELECTRICAL CONSTRUCTION AND MAINTENANCE

KNOW YOUR WHOLESALER ... BETTER

One of the most important contacts the electrical contractor and industrial electrician has is the electrical wholesale distributor. He is the one who stocks the necessary electrical equipment and supplies needed to make an installation quickly, completely and profitably.

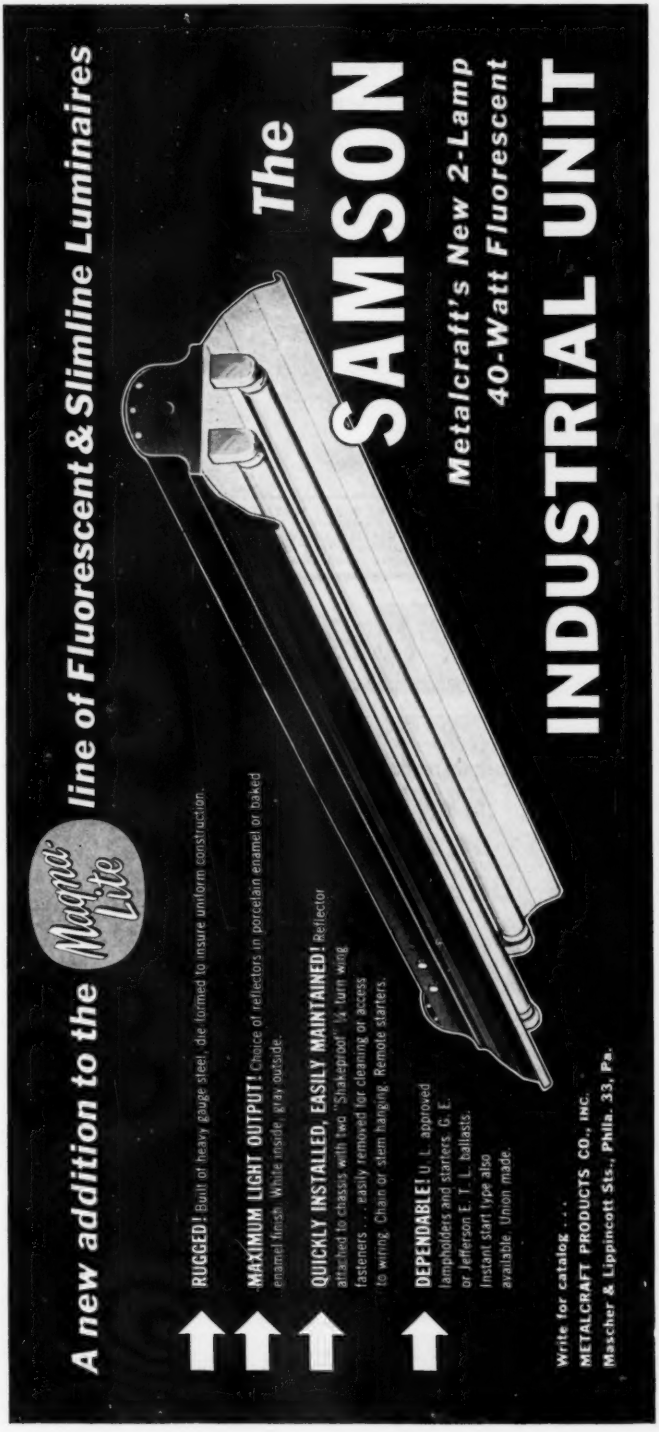
But this is only half of the story. Today, with industrial mobilization shifting into high gear ... with flash shortages throwing work schedules out of kilter ... electrical wholesale distributors and their salesmen can render other vitally important services: point out those activities that will be permitted to proceed at full speed ... where and how to get the most business out of sub-contracting and new plant programs related to the Defense Production Act ... explain the outlook for products containing controlled materials ... manufacturers' production plans, allocations, new designs and the use of substitute materials.

Electrical wholesale distributors and their salesmen, with a backlog of World War II experience, are well informed, strategically located and completely equipped to serve the needs of electrical construction and maintenance men throughout the country.

Better than 9 out of 10 electrical wholesale distributors get their information from

ELECTRICAL WHOLESALING

The National Magazine of Electrical Wholesale Distribution

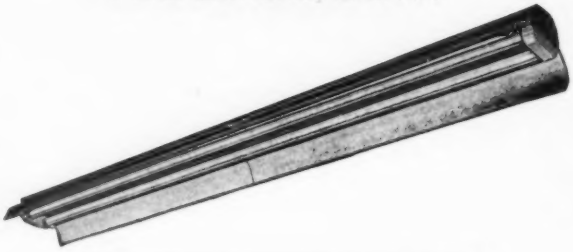

A new addition to the Magna-Lite line of Fluorescent & Slimline Luminaires
The SAMSON
Metalcraft's New 2-Lamp 40-Watt Fluorescent
INDUSTRIAL UNIT
RUGGED! Built of heavy gauge steel, die formed to insure uniform construction.
MAXIMUM LIGHT OUTPUT! Choice of reflectors in porcelain enamel or baked enamel finish. White inside, gray outside.
QUICKLY INSTALLED, EASILY MAINTAINED! Reflector attached to chassis with two "Shakeproof" ¼ turn wing fasteners ... easily removed for cleaning or access to wiring. Chain or stem hanging. Remote starters.
DEPENDABLE! U. L. approved lampholders and starters. G. E. or Jefferson E. T. L. ballasts. Instant start type also available. Union made.
Write for catalog ...
METALCRAFT PRODUCTS CO., INC.
Mascher & Lippincott Sts., Phila. 33, Pa.

KEEPING PACE

WITH THE NEW STANDARDS OF ILLUMINATION

MULTI

"FLUOROMOUNT"



96" LONG FOR THE T12-75 WATT LAMPS—LONG ON QUALITY AND PERFORMANCE. PORCELAIN ENAMELED REFLECTOR TO REALIZE THE FULLEST EFFICIENCY OF THE HIGHER LUMEN OUTPUT OF THESE NEW LAMPS. ONE PIECE STURDY HOOD CONSTRUCTION.

MULTI ELECTRIC MFG., INC.

4223-43 W. LAKE ST. CHICAGO 24, ILL.

TIME SWITCHES MUST BE RELIABLE!

You're SURE if You Specify

PARAGON

On any application . . . controlling yard or remote building lights . . . operating motors, stokers, burners or other industrial equipment . . . the time switches you use *must* be reliable. That's why it's smart to use Paragon's *built-in* accuracy and reliability.

Available in a wide variety of types and models for all "ON and OFF" timed-switching operations — indoor or outdoor. Time switches . . . interval timers . . . 7-day program controls . . . cycle repeaters . . . time-delay relays and reset timers . . . there's a dependable Paragon Time Control to fit your needs. 300 Series from $10.50 list.

Illustration shows Model 301 straight "ON and OFF" Time Switch for use where two or four operations per day are required. Self-starting, heavy-duty motor, available in 115 or 230 volt, SPST, SPDT and DPST models.

WORLD'S LARGEST EXCLUSIVE MANUFACTURER of TIME-CONTROLS FOR ALL USES

See Your Jobber or Write for Information and Catalog

Paragon ELECTRIC COMPANY

1614 TWELFTH STREET • TWO RIVERS, WISCONSIN

DID YOU KNOW THAT...

In 1950 Electrical Construction and Maintenance published 13 articles on estimating? Basic stuff this estimating, very often it draws the line between profit and loss. By popular request last year's articles will be consolidated in one reprint. These reprints will become available shortly.

During 1951 you'll find articles on estimating in just about every issue. Read them carefully and put them to profitable use in your business.

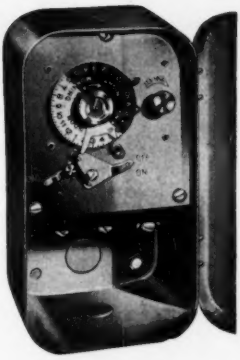
• • •

In 1950 Electrical Construction and Maintenance published 27 articles on industrial and commercial wiring and equipment installation?

Again during 1951 devoted attention will be given to wiring. For new techniques...time and cost saving methods . . . be sure to read these articles.

The Swing is to "US" Electric Plants
More and more fire departments are turning to "U.S." for *dependable* emergency power units. Portable and Stand-by plants. *Write for complete information.*
United States Motors Corp.
580 Nebraska St.
Dept. G
Oshkosh, Wis.
UNITED STATES MOTORS CORPORATION
US
OSHKOSH, WISCONSIN

NOW...THE RELIANCE "Model 400"



Here's a new, low-priced, smaller time switch that provides dependable automatic circuit control up to 2500 watts. The "Model 400" embodies all of the important features of the higher-priced Reliance time switches . . . and all the quality you expect of Reliance.

Listed by Underwriters' Laboratories, Inc.

For complete information on the new Reliance "Model 400" time switch, send a card today, to:

RELIANCE AUTOMATIC LIGHTING CO.
1937 Mead St. Racine, Wisconsin

Type 401—S.P.S.T.
20 AMPERES—125 VOLT

Only $10.00 LIST

RELIANCE TIME SWITCHES

Send For This Valuable Mailing List Data!

To aid you in planning your direct mail, check any of these mailing lists you may be interested in . . .

- ☐ Business Executives
- ☐ Electrical Appliance Dealers
- ☐ Manufacturing Industries
- ☐ Metal-Working Industries
- ☐ Aviation Industries
- ☐ Bus Industry
- ☐ Chemical Processing Industries
- ☐ Civil Engineering and Construction Industries
- ☐ Coal Mining Industries
- ☐ Electrical Industries
- ☐ Electronic Engineers
- ☐ Food Industries
- ☐ Metal Mining Industries
- ☐ Power Plant Engineers
- ☐ Product Design Engineers
- ☐ Textile Industries
- ☐ Welding Industry

. . . attach this 'ad' to your business letterhead . . . and mail. We'll send you complete information, selections, list counts, and prices. No obligation, of course.

Direct Mail Division

McGRAW-HILL Publishing Company

330 W. 42nd St., New York 18

"Friction Set" Fixture Hangers

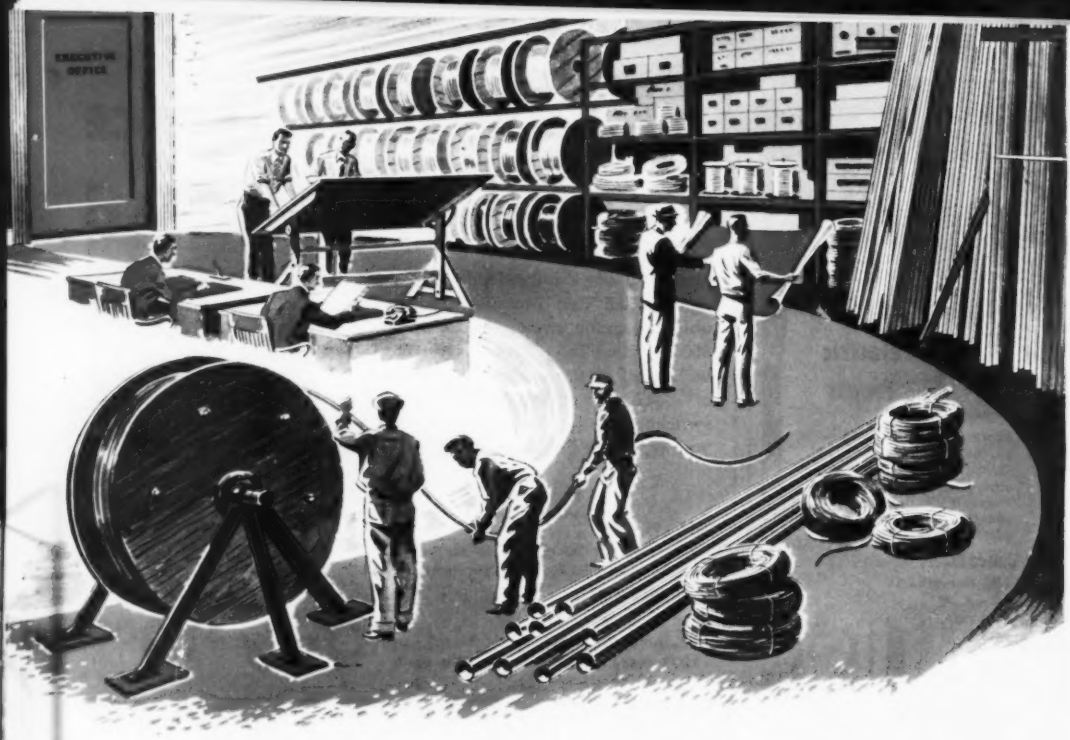
FOR INSTANT ALIGNMENT

At last you can get a Fixture Hanger that turns to any angle after being screwed to an outlet box. Although base and receptacle remain stationary, hanger arms may be turned to align with any preconceived lighting plan. Exclusive Friction Ring firmly holds fixture in selected position. Hanger screws on to 3¼" or 4" outlet boxes, no other fastening necessary. Furnished complete with receptacle, two 5' chains, hooks and cord clips. Also available with bushed hole only, or with 3 wire solid ground receptacle. All Friction-Set Hangers are approved by the Underwriters' Laboratories.

K100 shown above. List Price $1.10 • *Write for Bulletins K25, K26 and K27*

SIMPLET ELECTRIC COMPANY

3600 West Potomac Avenue, Chicago 51, Illinois
11 Park Place, New York 7, New York



Modern Management and Methods

ELECTRICAL construction, installation and maintenance operations are a complex pattern of management, engineering, technology and specialized skills. Work is contracted for or negotiated by electrical contractors through conventional business processes. It takes working capital, access to credit, tax and cost accounting, experienced purchasing, payroll procedures, billing and collecting. It involves substantial risks, and like any other business must return a profit.

Under exacting tax requirements, the stimulus of prosperous times and the patient but compelling effects of research, industry business practices are showing strong progress. And, from the base of sound business management, there has grown an increasing interest in effective work organization and job methods.

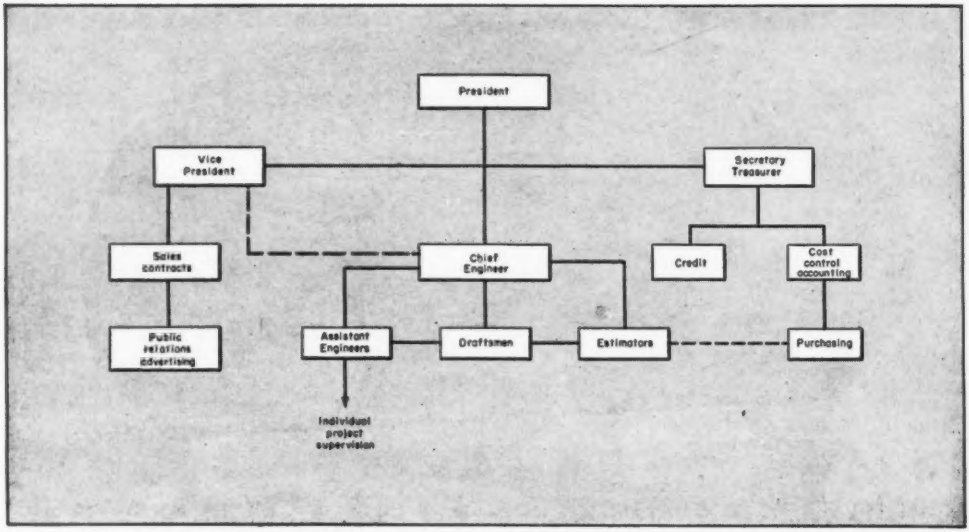
On the engineering and design level, the industry is far better equipped than ever before in its history. There are more jobs and higher responsibilities for trained electrical engineers. With the growing complexity of wiring systems, more detail decisions are required at the drafting board in working drawings.

Power and machine tooling on electrical work has made enormous progress in a comparatively few years and is still gaining rapidly in acceptance and new adaptations. Tools and equipment, once minor items of job management, have grown to major stature involving large investments.

Still predominant in influence on management and methods is the skillful and experienced selection and adaptation of the ever widening array of electrical equipment, materials and components to practical installations. Here is a frontier with no apparent limits to the horizon of future progress.

NEW FRONTIERS FOR ELECTRICAL PROGRESS

MODERN MANAGEMENT



MANAGEMENT ORGANIZATION CHART for a typical electrical contracting firm. While size of management personnel may vary depending upon size of firm, responsibilities of each memberof organization should be clearly defined.

Today's keen competition in the construction field demands a high degree of organization, backed by up-to-date know-how, modern methods and practical operational techniques.

LIKE any other successful business venture, an electrical contractor's operation must be well managed. Financing, purchasing, engineering and estimating, material and tool supply, labor management, sales effort, job management and cost control are all operations which are the direct responsibility of home office management. The skill with which his staff handles each assignment will be the yardstick to his success in this field.

The actual size of a contractor's staff depends to a considerable extent upon the type of work he does and the specific trade area in which he operates. This may vary from the one-man operation where the owner works with the tools (normally found in the small towns and rural areas) to the highly organized company with a half-dozen or more electrical engineers on the payroll. The number of top management men and the diversity of their functions will vary accordingly. One contractor considers the following as *minimum* for efficiently operating an all-around contracting business:

1. Manager
2. Estimator and superintendent
3. Bookkeeper
   Clerk—typist—telephone operator—pricing clerk
4. Storekeeper
   Truckdriver

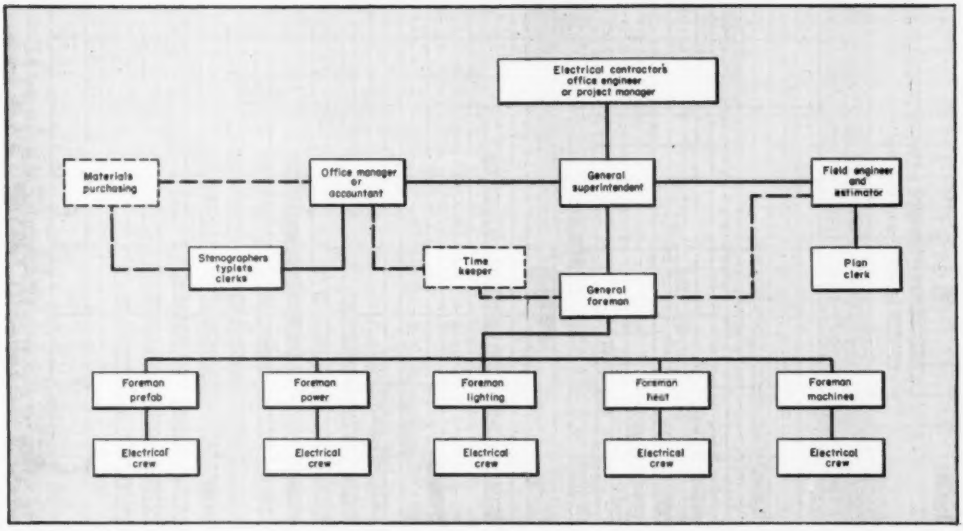
This basic setup is expanded to meet the operating requirements of larger firms. Above the manager, may be a higher echelon of management—officers and board of directors—to formulate operating policy. Each officer generally has direct responsibility for a definite phase of the business operation—finance, sales, engineering, and others. Under each come the actual operational heads—manager, engineer, estimator, construction superintendent, etc.

With the growing complexity of electrical systems in industrial and commercial buildings, electrical contractors have followed a trend of departmentalization in their headquarter organizations. Many now have separate lighting sales and engineering departments, motor repair departments, electronic sections (for industrial control and public address system engineering and installation). Again, the degree of departmentalization is a function of the type of contracting operation.

MATERIALS CONTROL

Practically all contracting firms maintain some stock of construction materials—fittings, conduit, wire, switches and controls. The type and size of the inventory depends upon the general type of contracting business being carried on. The firm doing a considerable number of small or medium sized jobs may

AND METHODS



FIELD ORGANIZATION CHART of a contractor's operation on a specific project. Although number of men on the project varies with size of job, the line of authority follows this general pattern.

maintain a substantial inventory to gain the price advantage on quantity purchases. Firms doing large projects generally order materials to be delivered direct to the job site—a method which eliminates warehousing costs and yet provides the price advantage of large scale purchases. The degree of warehousing on the part of the contractor will vary with conditions in the material supply field. When materials are in abundant supply and there is no danger of delivery delays, warehousing is generally held to a minimum—enough materials to get a project started immediately. When conditions are such that material items may become short in supply and deliveries may become long, the tendency to warehouse and maintain a substantial inventory increases. An astute purchasing and inventory control policy on the part of management can often mean the difference between profits or losses on construction work.

The importance of establishing a well organized material procurement system is evidenced by the standard cost ratio on electrical construction work. Research studies over the years have shown that approximately 60% of the base cost of electrical construction is represented by material purchases; 40% by labor required to install these materials. This M/L ratio may vary with the individual job, but whatever it may be the value of having materials on the job when they are needed cannot be over emphasized.

Standard practice is to order materials immediately after the contract is signed. The list is compiled from the estimators take-off sheets and recap sheets. Orders are generally placed with suppliers whose quotations were used in assembling the complete bid. Variations from this practice may take place, depending upon the supplier's ability to meet necessary delivery dates, or possible interim substitution of equipment items which, though higher in first cost, may contain features which would save installation labor for the contractor.

The last two conditions may well swing the balance in favor of one supplier against another in today's material market. The supplier who has the stock and can unquestionably guarantee the delivery will get the order.

MATERIALS SCHEDULE

How can the electrical contractor know at the start of a job just when various materials are going to be needed? Since he must closely coordinate his work with that of the general contractor and other trades on the projects, he should—and normally does—contact the architect and builder and secure their work progress schedule. With this as a guide, he determines delivery dates on his own material items and issues instructions accordingly. To assure continuous flow of materials, he can develop his own material schedule to fit the expected job progress. On this sheet, he lists the various material categories, dates ordered, desired delivery date and space for date delivered. As definite job schedules are prepared, these tentative delivery dates may be narrowed down to meet new installation requirements. With a schedule of this type kept up to date, management has a clear picture of material flow to the project.

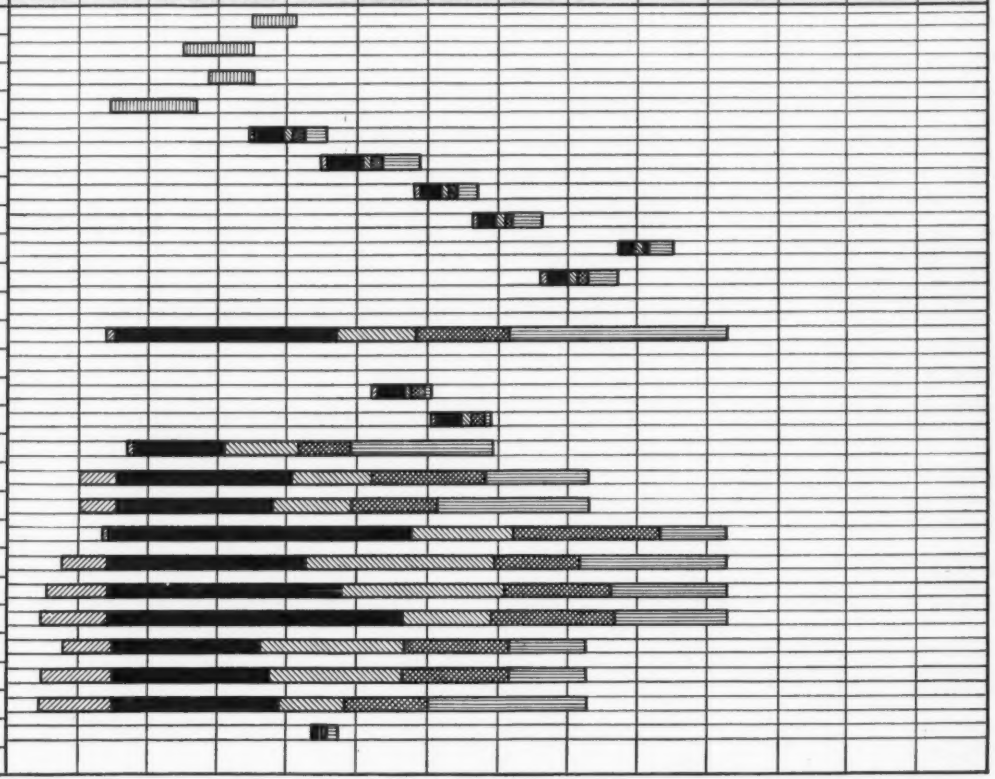
Close cooperation between contractor and supplier is important to maintain the material control so necessary to an efficiently operating job crew. Such cooperation is usually the outgrowth of long experience and

PROGRESS CHART—DC/AC CONVERSION

LEGEND

(Yellow)-cut holes in floors
(Orange)-conduit, P.B. & CSB
(Blue)-panelboards
(Red)-feeder cables
(Green)-branch wiring
(Black)-complete bid

BID ITEM	DESCRIPTION	PRIORITY
1	Light and power service buses	2
2	Service swbd & C.E. meter panel	5
3	Distribution buses E & W	4
4	Distribution swbds E & W	3
5	Lighting dist. system L-1	6
6	Ditto L-2	6
7	Ditto L-3	6
8	Ditto L-4	6
9	Ditto L-5	7
10	Ditto L-6	6
11	Ditto L-7	Omit
12	Ditto L-8	1
13	Ditto L-9	Omit
14	Ditto L-10	6
15	Ditto L-11	6
16	Lighting dist. system L-12	1
17	Ditto L-13	1
18	Ditto L-14	1
19	Ditto L-15	1
20	Ditto L-16	1
21	Ditto L-17	1
22	Ditto L-18	1
23	Ditto L-19	1
24	Ditto L-20	1
25	Ditto L-21	1
26	Power dist. system P-1	6
27	Ditto P-2	6



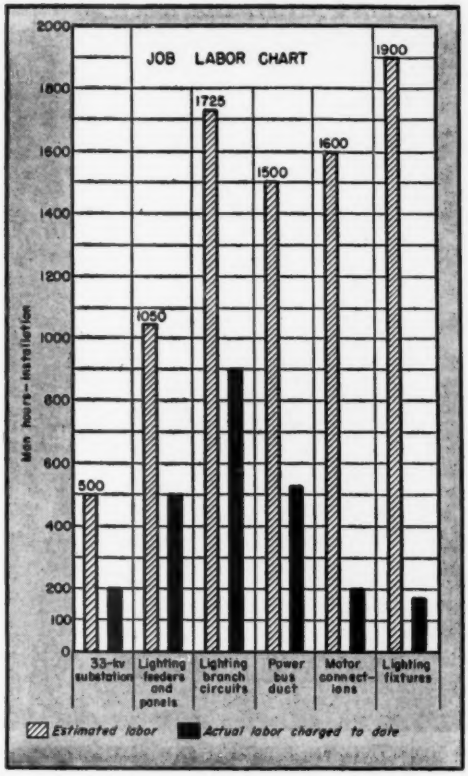
CONTRACTOR'S JOB PROGRESS CHART on an extensive electrical conversion project. Installation categories and priority listing followed schedule agreed upon by consulting engineer and owner; served as guide for determining manpower and material requirements during length of job. Blank horizontal bars were filled in as portions of job were completed.

efficient management on the part of both the supplier and contractor. It is for this reason that contractors generally oppose the practice of some owners who insist upon supplying all material the contractor is to install. While the contractor's margin on materials is obviously bypassed by the owner, the overall economy of this practice is highly questionable.

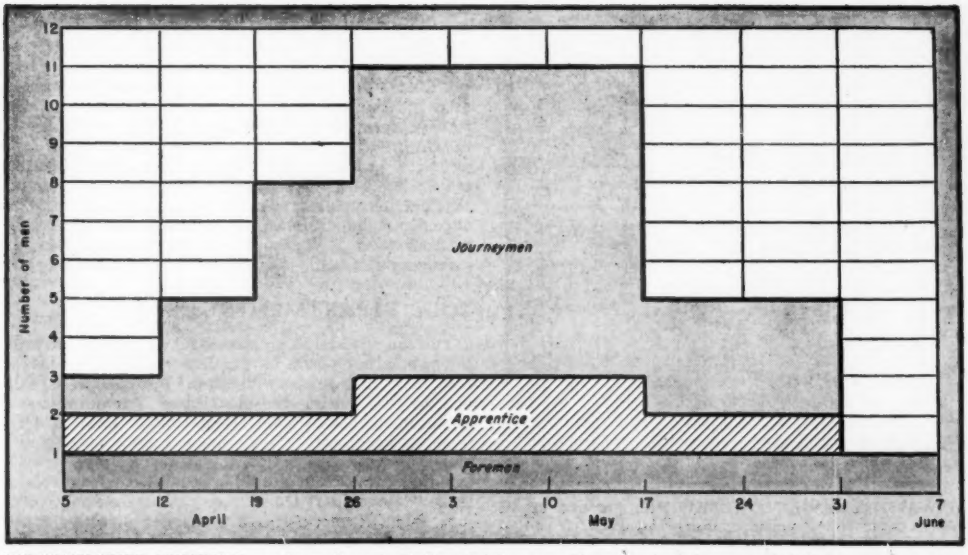
ENGINEERING

Engineering is becoming a progressively important phase of any electrical construction business. Most contractors have one engineer-estimator on their headquarters staff. Some of the larger firms employ as many as six to ten or more engineers, depending upon the volume and type of work they have on their books. This trend is by no means an attempt to bypass the established consulting engineer. Rather, it is a necessary adjunct. The contractor's engineer adapts the consulting engineer's design and layout to fit the specific structural and installation conditions encountered on the job and to comply with local governing electrical ordinances.

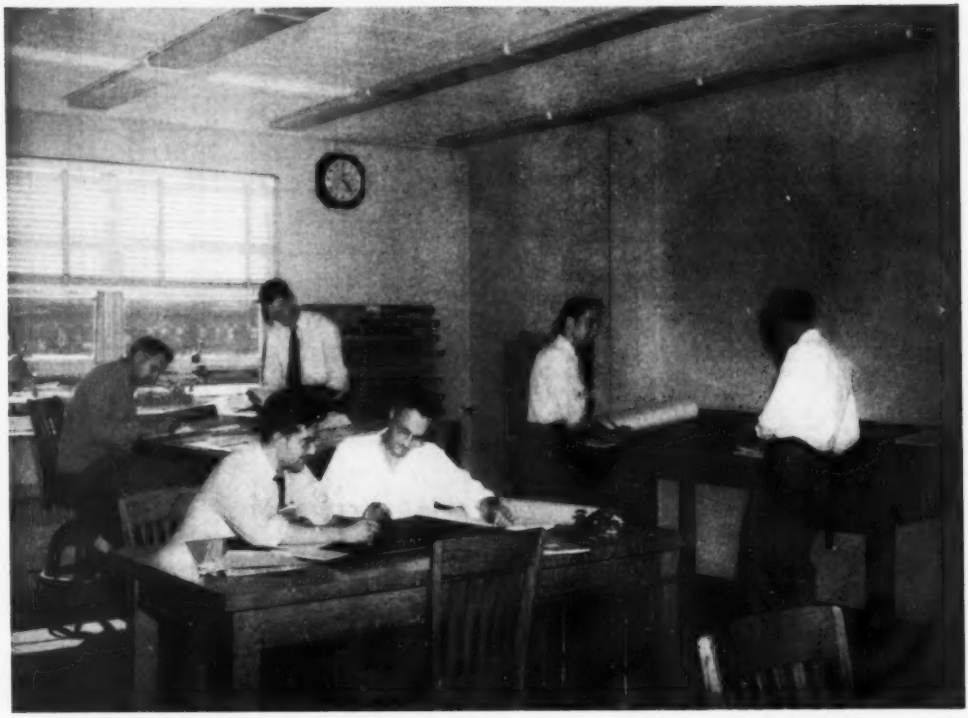
Construction engineering of this type has grown over the years. Basically, it is an outgrowth of the contractor's desire to give his men on the job a clear cut set of plans from which to work efficiently. It has substantially reduced the need for conjecture and assumption on the part of the job foreman; has eliminated, to a large extent, costly installation mistakes which later had to be rectified. Another factor having a direct bearing on this trend has been the number of inadequately engineered and incomplete (electrically) plans and specifications reaching con-



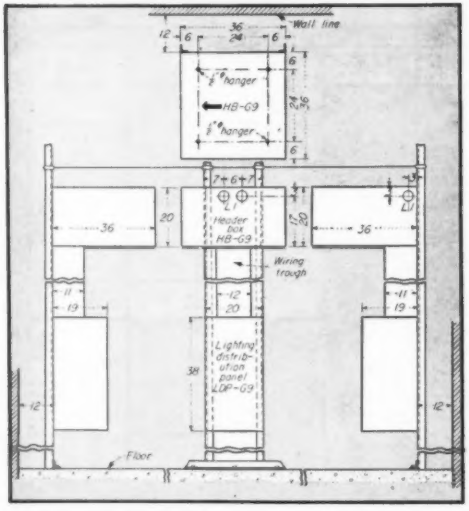
COMPARISON BAR CHART of estimated and actual expended labor is used by some estimators and job supervisors to follow job labor. Expended labor bar in each category is extended each week to keep chart up to date.



JOB MANPOWER SCHEDULE can be made at beginning of job as a guide to number of men needed during various phases of the installation.



A COMPETENT ENGINEERING AND ESTIMATING staff is one of the most valuable assets of an electrical contracting firm. Here plans and specs are double checked before a project is started; additional engineering done if necessary.



DETAILED DIMENSIONAL DRAWINGS prepared in the shop or field office eliminate confusion and doubt on part of installation crews, add to overall job efficiency, and generally speed construction details.

tractors hands for estimates and quotations. A contractor cannot offer an intelligent bid unless plans and specs indicate precisely what he is to figure on installing. A staff engineer has been the answer to this problem; also an assurance that the customer will get a carefully designed and engineered installation.

In the average size electrical contracting firm, the staff engineer may also do the estimating or supervise it. His engineering background, knowledge of construction problems and judgment on job scheduling are an important asset when estimating an electrical construction project. Such a combination of talent is difficult to find. Hence, the trend of electrical contractors to employ graduate or experienced electrical engineers and train them in the art of estimating.

TOOL DEPARTMENTS

You can have the most competent electricians to man a job, but they would be worthless without the necessary tools with which to install the equipment. One of management's prime responsibilities is to develop and maintain an adequate inventory of the most modern construction tools. This would include expendable tools (hacksaw blades, gas for soldering, pipe threading dies, twist drills and other small items) as well as those "depreciated" tools which can be used on several jobs. The former items are charged directly to the job as is material and labor. The latter category includes heavy equipment and power tools (pipe vises and stands, hydraulic benders, motorized pipe

FIELD OFFICE on a large electrical construction project handles all field engineering, material procurement and control, manpower requirements and detailed cost accounting; leaves home office staffs free to work on other contracts.

machines, drills, compressors, power hack and band saws, electric winches and others). Such an inventory involves a substantial outlay of cash for original cost, insurance and monthly maintenance. However, when the labor-saving features of power tools are carefully analyzed, the shadow of high original cost fades. It is well established that many contractors have been highly successful in competitive bidding because of their ability to reduce man-hours per job by the use of modern tools.

Another management responsibility is to see that adequate numbers of the proper types of tools are delivered to field projects, and that the cost of such tools is properly charged to the job. Research studies have shown that the actual cost of tools per month to equip an electrical construction job may run about *three percent of the monthly estimated labor.* Generally, this percent of payroll method of establishing tool costs on a specific project is preferred.

One method of establishing a reasonably accurate tool cost is to use a percentage of the purchase price of each tool as the estimated cost per month. Such a percentage includes interest, depreciation, repairs and obsolescence.

Most contractors paint their returnable tools a distinctive color for quick identity on the job. In addition to reducing the number of "lost" tools on a job, this practice has a definite advertising value.

Establishment of a definite tool replacement policy is also a sign of a well managed electrical contracting firm. Such a policy takes into consideration the estimated life of the specific tool, amount of use, type of use, depreciation and obsolescence. The progressive operator will replace his old items with the most modern and efficient tool on the market. An investment of this type generally pays off many fold and is an assurance of efficient job operation and profits.

Issuance of tools to specific jobs can follow many patterns. The method used will depend largely upon the size and type of project. Some contractors, on smaller projects, use the tag system on heavy and electric power tools. The electrician's payroll number is stamped on a metal tag which is hung on the bin from which the tool was taken. This employee is then held personally responsible for the return of the tool to the shop.

CONTRACTS AND CASH FLOW

Generally, there are three types of contract used for electrical construction work. They are:

1. *Lump Sum Contract*—in which the contractor agrees to install the electrical system as per plans and specifications for the sum of money he stipulated in his bid quotation. In this type of agreement, the contractor takes all of the risks.

2. *Cost Plus Percentage Contract*—in which the contractor agrees to install an electrical system in accordance with plans and specifications for an agreed percentage of base cost of labor and material to cover his overhead and return. Such a contract is often used on projects which are exceptionally difficult to estimate

COOPERATION BETWEEN contractor and material supplier will minimize material procurement problems; add to overall efficiency of a contracting operation.

CLOSE LIAISON BETWEEN owner's engineer and contractor's engineer helps solve construction problems before they result in costly installation errors.

MODERN MANAGEMENT AND METHODS (continued)

accurately because of intangibles which may enter the picture. Generally, the maximum cost to the owner is established by a preliminary estimate, and the contractor tries to complete the job under this figure. Electrical system rehabilitation, changeover work and rewiring are generally done under this type of contract. Sometimes new construction is done on this basis, but primarily when the contractor is handed the job without competition. Contractor risk in this type of agreement is held to a minimum.

3. *Fixed Fee Contract*—in which the contractor agrees to install an electrical system for a fixed lump sum fee determined by negotiation before the contract is let. This fee may be a definite percentage of the estimated total cost of the installation. The fee is fixed and does not increase if the total cost is above the estimated maximum, nor does it decrease if the job is completed under the maximum figure. If the cost is above the estimated figure, the contractor is paid for his material, labor and job costs but no additional fee unless he can renegotiate successfully for an added fee. This type of contract was prevalent on large defense construction projects during World War II and may crop up again during the present emergency. Contractor risks under these agreements are also minimized.

Regardless of which type of contract is used and whether the contract closing follows a formal or informal procedure, there are several points which must be clearly defined at that time:

1. The order should be in writing.
2. There should be a clear, concise definition of the scope of the work.
3. The exact contract price or percentage of fee should be definitely stated.
4. Terms of payment should be clearly understood.

It is advisable to have an understanding as to how possible radical changes in original plans and specifications made during the progress of the job should be handled. Some plans and specifications make provisions for extra compensation for design or installation changes which go beyond a certain magnitude; others do not.

Agreement on terms of payment on contracts has a direct bearing on the length of time and amount of money a contractor will have tied up in the job.

A construction program schedule is the key to estimating cash flow requirements. Data secured from manpower schedules of various projects will indicate the monthly amount of cash needed for payrolls; similar data from materials delivery schedules will indicate cash required to discount these invoices. Other overhead and job expenses can be prorated on the same time axis. Deduction of expected monthly payments on contracts, allowing a realistic time lag and retained percentage, will give the total estimated monthly cash outlay. Original estimates may vary as jobs progress; hence management must keep in close touch with its several field organizations.

Normal procedure is for the contractor to be paid monthly on the basis of work installed. When the job is completed, 15% of the contract price is generally withheld until the owner has proof that all bills and liens against the contractor have been paid. Under present conditions, some owners are paying the contractor immediately for all materials delivered to the job, even though such materials may not be installed for several months.

JOB RECORDS AND CHARTS

It is good, sensible business practice to know just where you stand each month with respect to cash outlay, accounts receivable, accounts payable, materials and equipment inventory, job progress and manpower availability. Having much of this information is the responsibility of the bookkeeper or accounting department. Job progress and material inventory data generally comes from the shop construction departments, estimator-engineer, and stock room clerk. Shop control of field projects is effectively maintained by using the "job-envelope" system. All data pertaining to a specific job is filed in a single envelope under the job heading—material invoices, man-hour time sheets, tools and equipment requisitions and records, original estimate, copies of original contract terms, copies of change-orders, and all other information pertinent to the specific contract. In fact, the envelope is a complete history of the job, a compilation of accurate cost data and job facts which can be used by the bookkeeper or accounting department in establishing cost records and for the engineer-

PERIODIC VISITS between contractor and his job superintendent pay off even on the small projects. Without adequate front office supervision, jobs can easily get out of hand.

RADIO-TELEPHONE in superintendent's truck keeps him in touch with home office and projects as he makes his inspection rounds.

estimator in establishing specific installation costs and a running comparison between actual job costs and estimated costs.

Job progress charts of various types are also used in the shop to give a reasonably accurate picture of job status on various projects under construction. A general contractor's job schedule can be effectively used to set up a delivery schedule for electrical materials and equipment. Tentative manpower schedules for projects can be made to show the anticipated labor requirements and peaks on the job. These, in turn, can be used to set up a cash-flow schedule to meet payroll and material payment demands.

Some contractors use vertical bar comparison charts for job labor. The vertical axis shows man-hours. The horizontal axis is divided into sections representing work categories on the job. Each work category has two vertical bars—one representing the estimated labor, the other showing actual labor (in man-hours) expended to date.

Frequently, on large projects, electrical installation progress wall charts are developed for each specific project. These are generally of the horizontal bar type with time in months, or days, on the horizontal axis and installation category or contract bid items along the vertical axis. The horizontal bars are filled in with colored pencil—a different color being used for each type of operation (conduit, cables, panels, switchgear, etc). From such a chart, monthly billings can be readily made on the basis of work installed to date.

JOINT-VENTURE OPERATION

World War II established joint-venture operation as an effective means of handling exceptionally large installations in an efficient manner. This type of operation, in effect, pools the management, engineering and construction know-how as well as material, financial, equipment and manpower facilities of two, three or more electrical construction firms on one project.

Two types of organizational schemes were used. One was the establishment of an entirely new company which existed, as such, only for the life of the job. Top personnel from each of the contracting firms involved headed up the field organization and new com-

TOOL COST GUIDE

TOOL ITEM	COST PER MONTH*
Pipe Tools	
Large Benches	6
Small Benches	4
Vises—1/2" to 2"	12
Vises—2" to 4"	14
Stocks—1/2" to 1 1/2"	10
Stocks—2" ratchet	11
Stocks—2 1/2" to 4"	12
Dies—1/2" through 2"	60
Dies—2 1/2"-3"	30
Dies—4"	25
Power Driven Thread Cutter	7
Bender—small and large	6
Hickies—1/2"-1"	10
Thin Wall Bender—1/2"-1"	10
Wrenches—18"-24"	10
Chain Tongs—1 1/2"-4"	10
Reamers—1/2"-3"	15
Oilers	33
Field Shop Tools	
Drill Press	5
Power Saw—universal band type	5
Copper Bender	4
Iron Bender—universal type	5
Electric Tool Grinder	5
Work Bench	6
Machinist Vise	4
Electric Welder	8
General Tools	
Steel Tool Boxes	5
Wood Tool Boxes	10
Ladder Chains and Locks	8
Step Ladders—6'-8'	20
Step Ladders—10'	22
Step Ladders—12'	28
Step Ladders—14'	32
Step Ladders—16'	33
Extension Ladders	10
Scaffolding Materials	20
Hand Tool Grinders	8
Electric Drills—1/4"-1/2"	7
Twist Drills	25
Taps	60
Whitney Punches and Dies	8
Knock-Out Punch Sets	20

TOOL ITEM	COST PER MONTH*
Air Hammers	8
Electric Hammers	8
Reamers	15
Files	50
Star Drills	40
Hacksaw Blades	100
Bullpoints	25
Pinch Bars	20
Socket Wrenches	10
Bolt Stock and Die Set	25
Extension Cords	50
Burners and Tanks	5
Ceiling Hoists	8
Chain Hoist—5-ton	4
Hemp Rope—1/2"-3/4"	30
Snatch Blocks	5
Wagon Trucks	8
Dollies	10
Jacks—stone	4
Sledges and Hammers	15
Chain—coil	5
Cable Installation Tools	
Fish Tape—1/8"-3/16"—100-ft.	50
Fish Tape—1/4"—200-ft.	30
Winches—hand and power operated	7
Universal Power Drive	7
Wire Rope—1/4"-3/8"—150-200-ft.	10
Cable Grips—"Come-Along"	15
Reel Jacks	6
Pick-Up Cart	8
Cable Brake	8
Payout Reels and Gang Type Reel Stands	4
Wire Strippers	8
Gas Furnaces	4
Electric Soldering Set	10
Steel Lettering Set	10
Special Portable Tools	
Floor Crane	5
Air Compressor	7
Electric Welder	8
Electric Flexible Shaft Grinder	8
Rolling Scaffold	10

* Estimated cost per month percent of purchase price includes interest, depreciation, storage, repairs, obsolescence, etc.

Research data compiled by Ray Ashley, Research and Consulting Engineer, Chicago, Illinois.

pany, but firm identities did not otherwise enter the picture. In another type, one officer of each of three electrical contracting firms formed the Administrative Board of the joint-venture, and firm identity was retained. Field organization personnel (top echelon) were recruited from each of the three firms.

In each instance, an efficient, closely-knit, and sometimes extensive field organization was established. The entire project—employment, accounting, purchasing, engineering, estimating, payrolls, invoice payments, etc., was handled at the job site.

The success of this type of operation gives considerable impetus to the present practice of establishing comprehensive, efficient field organizations on major electrical construction projects—whether the contract is handled by a single electrical contractor, or several under the joint-venture pattern.

JOB MANAGEMENT

Good management is not confined to the contractor's shop. Front office personnel has the responsibility of extending its management philosophy into the field on each individual project. The degree and efficiency of project management, coupled with an adequate supply of power tools, frequently determines the outcome of a contract with respect to return. Lack of such field management tends to increase the burden on shop personnel and may even set a limit on the number of projects a contractor can handle simultaneously.

Job management in the field follows a fairly set pattern that parallels shop management organization to some degree. On small projects it may consist of merely a few electricians with their foreman reporting back to the staff engineer-estimator. All material and labor requirements are handled from the shop. As projects increase in size and complexity, more and more of the normal shop personnel activities and responsibilities for that project are transferred to the field, and the job management set-up is expanded accordingly to meet these requirements.

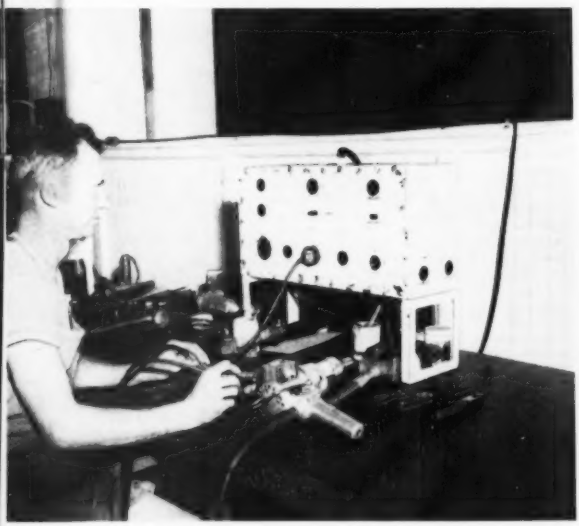
Normally, a field superintendent or project manager directly responsible to a staff engineer, heads up the field organization. Directly under the project manager are the general foreman and a number of foremen, depending upon manpower requirements. Each foreman has charge of a crew of electricians. If materials are ordered labor is hired and bookkeeping handled at the job, a purchasing agent, accountant and field engineer round out the top personnel of the field staff. Each department head has his own staff working under him, and he reports directly to the project manager.

CREW ORGANIZATION

Present trend on electrical construction projects is to organize electrical crews to perform specialized tasks. One crew may be assigned to underground work; another to substations; a third to power feeders; a fourth to lighting feeders; others to power distribution and lighting distribution; and separate crews to machinery installation and connection, if this forms a substantial part of the installation contract. Where there is a considerable amount of electrical heating equipment involved or complicated interlocking control systems, contractors have found it advantageous to assign special crews to each category.

FIELD ENGINEERING

The importance of field engineering cannot be over emphasized. Where doubt and confusion reign among installation crews, expended man-hours climb steadily. To reduce this possibility to an absolute minimum is the responsibility of the project field engineer. In collaboration with the project manager or field superintendent, he adapts the original plans and specifications to specific job conditions. He and his staff prepare necessary working drawings and detailed dimensional plans where required; incorporate any changes which may arise; forestall "right-of-way"



SMALL POWER TOOLS SHOULD be checked and repaired at regular intervals. All tools must be in top operating condition when sent to a job.

JOB COORDINATION is simplified by telephone intercom system between field office and installation areas throughout the project.

FORK LIFT TRUCKS replace block and tackle for lifting heavy electrical equipment into installation position. Here, lighting troughs are being held while mechanics fasten toe clamps to trusses in an industrial installation.

conflicts with other trades; act as an engineering liaison between the owner, architect, builder and contractor.

Basically, the functions of field engineering can be classified as planning, layout and installation. Planning, in the construction field, is primarily a matter of material and manpower control—having enough materials and men on the job at the right time to keep pace with construction progress. Also, using power tools and assembly-line techniques to the utmost to facilitate installation. While structural and electrical plans are generally checked when the project is being estimated, often it is at the job site where actual discrepancies are corrected and installation problems solved. Close cooperation between architect, owner, other trades and the electrical contractor is necessary to catch last minute changes in design or installation.

On-the-job layout involves incorporating necessary changes brought about by structural conditions and other trade conflicts. It is at this point where accurate dimensional drawings, pull-box designs, feeder layouts, patch-sections of general plans and field sketches play an important part.

MATERIALS HANDLING

The handling of electrical materials and equipment from the time of their arrival on the job until they are installed in place can account for a sizable portion of estimated labor. Strategic location of the stock and tool rooms has an important bearing on this cost item and is a major function of job planning.

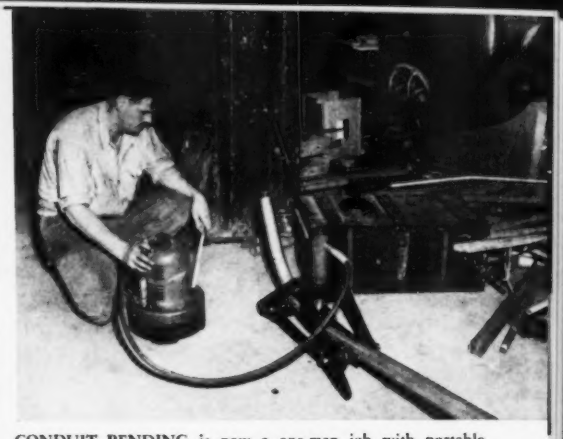
The number of material depots established on a job varies directly with the physical size of the project and the dispatch with which equipment can be moved from one location to another. One centrally located stock and tool room in combination with a field office may suffice on small and medium size projects. Where the building or buildings are spread out over considerable acreage or extend upward for considerable heights (as in skyscraper commercial buildings), more than one depot is necessary. Construction tools are normally spotted throughout the project in the same manner.

General practice on large projects is to confine all contractor field offices and stock rooms to one area of the plant property to provide a central receiving point for all material delivered to the job. Transportation of materials from this point to installation centers is the responsibility of individual contractors on the job.

Trucks assigned full time to the project are normally used to move heavy equipment and materials between buildings, and also within buildings when permitted. Where work is confined to a single structure, wagon trucks, either hand powered or pulled by small gasoline tractors, are frequently used. On multi-story type of construction, arrangements are normally made with the general contractor to use his materials hoist. Hand trucks take over at each floor level.

The motorized fork lift truck is replacing the old

POWER WINCH ON JEEP pulls cables through overhead conduit system in industrial plant electrical rehabilitation project, with horsepower replacing manpower.



CONDUIT BENDING is now a one-man job with portable power unit. Electrically driven hydraulic pump has finger-tip control.

MODERN MANAGEMENT AND METHODS (continued)

block and tackle for raising heavy equipment into place —particularly on jobs where heavy bus duct and other raceways must be suspended from ceilings and roof trusses. Roller conveyors are being used extensively to position heavy bus bars and cables when installed on open racks. Hydraulic tail gates now raise and lower large cable reels and other equipment on and off trucks. Wherever possible, some form of motive power is being used to replace sheer muscle power in handling materials on electrical construction projects.

JOB TOOLS

Complete mechanization is the goal toward which electrical contractors are striving, not only in handling of materials and equipment but also for actual installation of these items. One of the greatest strides made in this field over the past quarter century has been the adaptation and application of more power tools on the job. And this trend is still on the upgrade. The larger the job and the more complex the installation, the greater the number of tools that will be necessary to handle the project efficiently.

The bull point and sledge hammer have given way to the compressed air drill and electric hammer. Hand drilling is practically non-existent, and even the electric drill is being supplanted by stud welding and powder actuated tools for numerous fastening operations.

Power winches have relegated hand operated winches and snatch blocks to the sides lines. Power driven pipe cutters and threaders, metal cutting band saws and electric drill presses are common tools on today's electrical construction projects. Electrically driven circular saws are cutting steel panel openings, and rotary concrete drills are boring openings in tough concrete slabs in a jiffy. Even hydraulic conduit benders are now operated by a motor driven power unit. The list could go on practically indefinitely to include numerous improved hand operated tools.

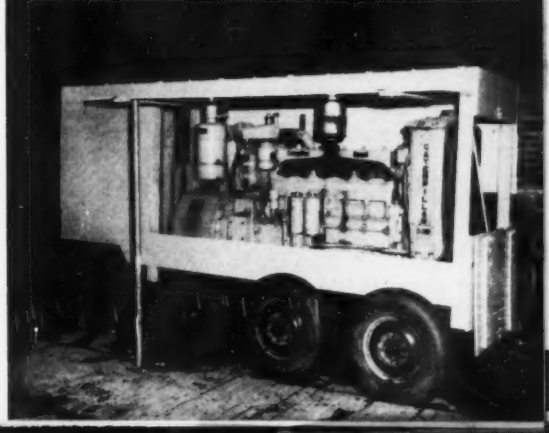
INSTALLATION TECHNIQUES

Paralleling the increase in mechanization in the electrical construction field has been the continued adaptation of mass production methods to equipment and material installation techniques. Assembly line tactics are finding broader application to prefabrication and preassembly of component parts of electrical systems. Standardization of system design and layout—particularly in multi-story structures—lends itself admirably to this type of field operation.

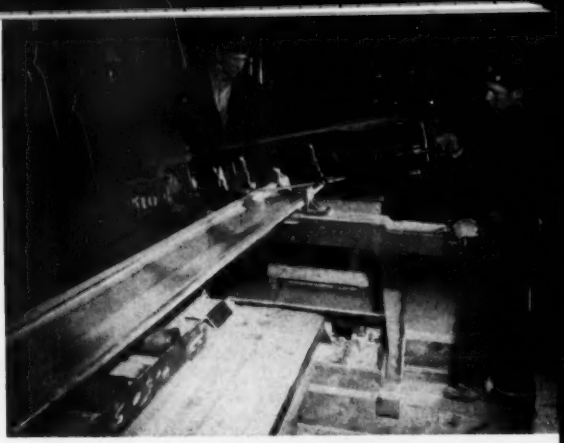
Normally, a pre-fabrication shop is set up on the

HEAVY POWER TOOLS substantially reduce manhours expended on an electrical construction job; are an important part of a contractor's tool inventory.

PORTABLE GENERATOR units furnish temporary power for electrically operated tools on construction projects, prior to installation of permanent power facilities.



PORTABLE HOLE BORING unit reduced noise to a minimum and sped drilling of several hundred holes in floor slabs in large commercial building rewiring project.



ASSEMBLY LINE and prefabrication techniques are used extensively on large electrical projects. Here, aluminum bus sections are passed over bench rollers to metal cutting band saw.

job site as near as possible to a central location to reduce long hauls to installation areas. Here a concentration of power tools, in assembly-line sequence, can be operated by a special fabrication crew. Conduit can be cut, threaded, bent, assembled and capped in large quantities, then bundled for delivery to installation crews. Under this plan, the number of heavy power tools needed on the job can be definitely limited without impairing operating efficiency.

Mobility, speed and efficiency are definitive of the modern electrical contractor in his continuous battle against time. He has learned from experience that jobs which go in according to schedule bring him a reasonable return and leave his organization free to compete for more work. Jobs which lag eat up profits and overhead and may tie up a good part of his manpower and equipment facilities.

JOB COORDINATION

The degree of speed and smoothness with which an electrical installation is made can generally be traced to an efficient method of job coordination. Not only has the modern contractor placed his equipment on wheels, but in many cases he has put wheels under his top-flight field personnel. It takes a long time for a supervisor to walk from the field office to a distant part of a large building, or from one building to another.

The telephone is another "job tool" that has become indispensable to the field office. There are always one or more public telephones in the field shop for contacting the home office, suppliers and others. In addition, many progressive contractors install their own private telephone intercom system between the field shop and various work areas throughout the project. Through it, the job superintendent and field engineer can quickly issue instructions, change orders and give vital information to foremen in the field. In like manner, foremen can get answers to their problems in a few seconds, can telephone orders and instructions to the prefab shop for materials and assemblies.

The short-wave radio system is gaining acceptance among contractors for both office and field applications. On large sprawling projects, supervisors' trucks and cars are equipped with two-way radio. Conversation between the supervisor and the field office personnel can be carried on while he is busy making his rounds and frequently problems can be settled without his backtracking to the office. Contractors whose main operations are concentrated within a limited radius of their home office are using this method to communicate with their supervisors.

TOOL TRAILERS multiply effectiveness of trucks in tool distribution to jobs; act as tool crib on outdoor work; can be locked to protect tools when not in use.

MOTORIZED VISE on pick-up truck speeds conduit coupling for underground lighting circuits. Trailer rig with gasoline driven generator powers unit on truck.

ESTABLISHING NEW

Electrical Frontiers

Since V-J Day, electrical power generating capacity of the public utility companies has increased 40%. Equipment orders already placed indicate a further expansion of 50% in the next 4 years—and that's only the beginning. The electrical manufacturers who supply generating apparatus have been growing step by step with the power companies. Westinghouse manufacturing capacity, for example, has increased 50% since the end of World War II.

Wesco, Too, Moves Ahead

To furnish apparatus, supplies and multi-services to thousands of electrical contractors, industrials and other customers, the Westinghouse Electric Supply Company has grown with the years, in keeping with the need — 2850 employes in 1941 have become 6246 in 1951; 66 branch offices in 1938 are now 109, located in 45 states. This year, Wesco markets 18,000 different items, more than three times the variety of 10 years ago. In 1950, Wesco dollar business was 4½ times the largest pre-war year.

New Horizons

As you our customers—and we—move forward in the unfolding future of electrical development in this country, you will need service and "know-how" as never before. Wesco will be able to supply them to a larger, more satisfying degree. Wesco can bring the resources of trained personnel and long experience to bear upon your particular problems. Meeting new challenges, and keeping alive the spirit that has built this business are as much a part of Wesco growth as its physical development.

When you face a new problem, when you need service fast, when you want to explore the best ways of doing any job better—in short, when you want up-to-date and intelligent cooperation—come to Wesco—first.

Westinghouse Electric Supply Co.

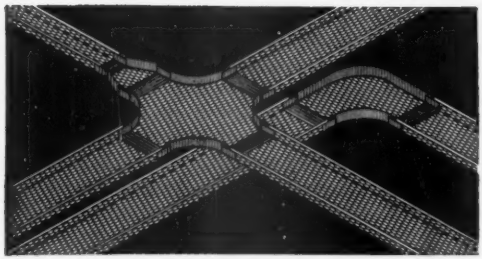
A National Distributing Organization

40 WALL STREET, NEW YORK 5, N. Y.

In This
NATIONAL EMERGENCY

Save MATERIAL
Save MAN-HOURS
Save COSTS

with the new system of
COPE CABLE TROUGHS



Today's State of Emergency requires everyone to make savings wherever he can. By using Cope Cable Trough, you save in all possible ways . . . *material, man hours* and *costs.*

In addition, there is no better system on the market for the support of Cable and Instrument Tubing.

MODERN, STREAMLINED DESIGN—Conserves material and at the same time makes the troughs simple and versatile.

MAN HOURS CUT—Engineering costs are slashed when Design Engineers can order a complete installation from the Cope Cable Trough catalog. Installation costs are cut to the bone with simplified assembly.

SAVINGS UP TO 66%—Users say Cope Trough saves them real money (one large utility stating as high as 66%) over other methods.

ENGINEERING HELP—Where unusual problems in your installation perplex you, instead of devoting *your* time to the solution, request our Engineering Staff to solve them for you. Every day Cope solves such problems for its customers.

If you have not already done so, write today for the new bulletin on Cope Cable Trough.

T. J. Cope INC.

T. J. COPE, INC., 711 SOUTH 50th ST.
PHILADELPHIA 43, PENNSYLVANIA

THEY MAY LOOK ALIKE... BUT NEVER ACT THE SAME!

Imitation, as the saying goes, is the greatest source of flattery. However, there are times when it can also be the greatest source of trouble. So, remember when buying, screw anchors...

THE INSEPARABLES

*Substitutes

CAN PROVE DANGEROUS!

The word "Rawlplug" used in connection with *Jute Fibre Screw Anchors* is exclusively the property of The Rawlplug Company, Inc. For forty years it has been secured to them by common law and by trademark registry. It is the corporate and trade name of the company and specific product of their manufacture.

BE SECURE BY BEING SURE

Look for the Trade Name **RAWLPLUGS** *on the* Blue Box

THE RAWLPLUG LINE

RAWL-DRIVES
Bolt and Anchor in one piece—drive like a nail into a drilled hole and holds like a bolt. Used only in hard materials, such as concrete, brick, etc.

RAWL-TAPERS
For machine screws. A Machine Screw Anchor that fits the hole drilled, either by a new or worn drill.

RAWL HAMMER-SETS
Heavy duty threaded type machine bolt anchor, ideal for bottomless holes, hard floor topping.

RAWL-ANCHORS
For holding bolts permanently in materials such as concrete, marble, stone, brick, etc. Heavy duty type.

RAWLDRILLS
The original 3-point drill for drilling holes in all masonry. Quickly and easily sharpened. For hand and power drilling. Also Rawl Carbide Tipped Drills for use in electric drills sizes 3/16" to 3/4".

When you use Rawlplugs you are using the original and genuine... the only screw anchor with the features that make them worthy of imitation... RAWLPLUG!

Rawlplugs because of their chemically treated braided jute fibre construction... Hold Better ... Last Longer ... Weigh Less and Hold More! They eliminate extra troublesome spotting and layout work. Rawlplugs are the only universal anchors which can be used in any material.

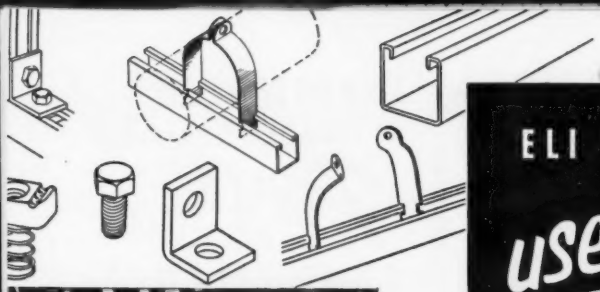
"IF YOU DON'T USE RAWLPLUGS... THERE'S A SCREW LOOSE SOMEWHERE"

For Information write Dept. E

12-L-11

The Rawlplug Company, Inc.
271 Church Street, New York 13, New York

THERE ARE RAWL EXPANSION BOLTS, SCREW ANCHORS AND MASONRY DRILLS FOR EVERY NEED. SOLD THROUGH ALL LEADING HARDWARE, ELECTRICAL AND MILL SUPPLY HOUSES.



ELI LILLY AND COMPANY

use UNISTRUT® METAL FRAMING

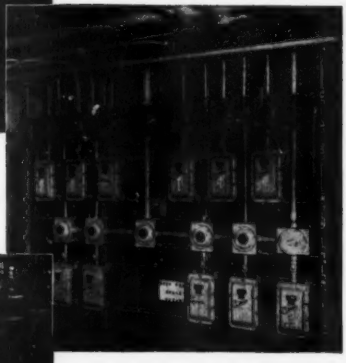
Stanchions and trapeze supports of UNISTRUT carry high voltage and metering conduits in a Lilly tunnel installation.

in countless plant maintenance jobs!

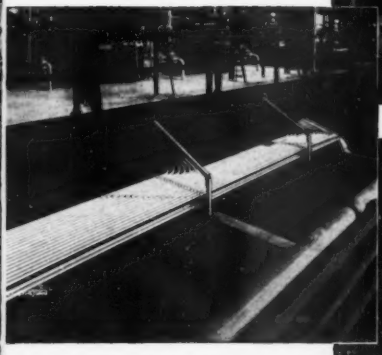
STOCKED IN ALL PLANTS AS STANDARD SERVICE STORES ITEM

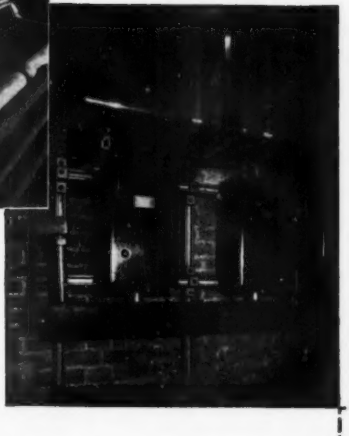
Lilly uses UNISTRUT to

- ★ **Rack Conduit, Cable and Mechanical Piping**
- ★ **Frame Power Load Centers**
- ★ **Mount Switches, Meters and Panelboards**
- ★ **Support Fluorescent Fixtures**
- ★ **Construct Assembly Tables and Conveyor Supports**



Load Center in Glandular Products section. Note how flexible UNISTRUT permits gear to be installed in exact location desired.





Here UNISTRUT carries heavy banks of conduit leading to motors in the penicillin fermentation area.

First UNISTRUT installation made at Eli Lilly, in 1942, supports motor controls for pumping equipment.

LILLY maintenance men find completely adjustable UNISTRUT all-purpose metal framing easy to handle and quick to erect, providing great strength without bulk. Adjustments, changes, and additions are easily made at any time.

UNISTRUT cuts costs, too. You save time in engineering detailing and eliminate the need for trained erection crews—anyone can build with UNISTRUT. No drilling, no welding, no special tools or equipment—all you need is a hacksaw and a wrench. It will pay you to stock UNISTRUT as a maintenance material.

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The World's Most Flexible All-Purpose Metal Framing.

Representatives and Warehouse Stocks in Principal Cities. Consult your Telephone Directories.

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2345650 2363382
2388379 2405631
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78-page UNISTRUT Construction Catalog No. 700 Write for your copy today!

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Please send the items checked below, without obligation:

☐ New Catalog No. 700 ☐ Wall Chart
☐ UNISTRUT Sample

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Company_____

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A Statement of Sales Policy

by the

ARRO EXPANSION BOLT CO.

1930 · 1951

The following is the Operating and Selling Policy of Arro Expansion Bolt Company, manufacturers of quality fastening and drilling devices for masonry—for over twenty years.

DISTRIBUTION—Arro products are sold nationally through qualified Wholesale Hardware, Mill Supply, and Electrical Supply Distributors.

INQUIRIES—All inquiries are referred to our distributors in their respective territories.

PRICES—Arro products are reasonably priced to promote their broad use by consumers. Distributor mark-up on the Arro line insures an attractive profit.

RESALE—Arro distributors are urged to respect our suggested resale prices. Every lawful method is used to encourage this fair practice of merchandising.

STOCK—Arro offers its distributors a complete line of fastening and drilling devices for masonry. We expect distributors to maintain a sufficient stock to adequately serve their trade.

SERVICE—Nine branch warehouse stocks are maintained in key cities, strategically located throughout the nation. All orders are shipped immediately from branch warehouse stocks and normally within 48 hours from factory stocks.

GUARANTEE—Arro products are fully guaranteed against defects in material and workmanship. Returned goods are accepted on authority of the Marion office only.

SALES AIDS—Arro helps promote sales for distributors by supplying a variety of sales literature, displays, and catalogs; by cooperating with their salesmen; and by regularly advertising in leading trade journals.

PARTICIPATION—Arro is an active member of leading industrial and trade associations.

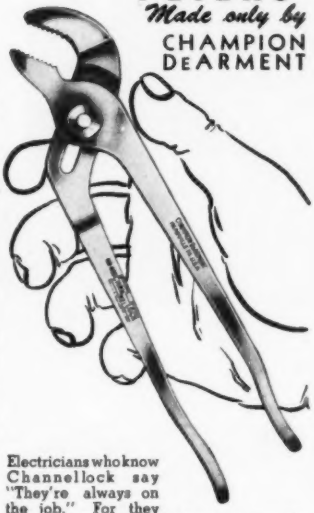
This has been our Sales Policy since our birth in 1930. We believe that this policy, possible only under the American system of free enterprise, has been an important factor in our substantial growth.

ARRO EXPANSION BOLT CO.

TRADE ARRO MARK MARION, OHIO

EXPERIENCED ELECTRICIANS *Prefer* CHANNELLOCK PLIERS

Made only by CHAMPION DEARMENT



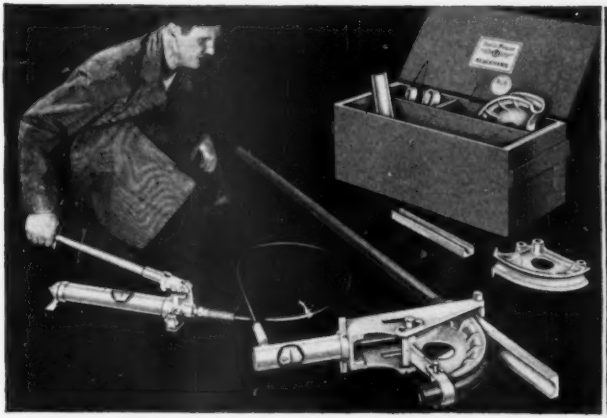
Electricians who know Channellock say "They're always on the job." For they know that Channellock pliers are versatile. Channellocks are more than pliers . . . they can be used where ordinary pliers are useless. They are strong, easily adjusted, self cleaning and versatile. Be sure you have a pair of Channellock pliers with your electrical tools. You'll find that Channellock pliers are the best. And remember, Only Champion DeArment makes Channellock. Send for Catalog D-5 today.

CHAMPION DEARMENT TOOL CO.

Meadville, Pa.

Channellock pliers are listed in the Yellow Pages of most Telephone Directories under "Tools"

5 WAYS to slash costs on pipe and conduit installations

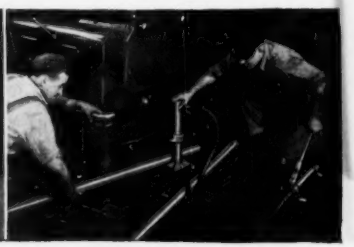


1 Now, THIN WALL Conduit can be bent profitably!

At last, this popular tubing can be shaped efficiently on the job-site — thanks to a new Bender, No. S-34. Remote control and other exclusive features create greater speed, better workmanship. Beautiful, kinkless bends, matched offsets and rigid installations are made in new record time. It handles 1¼, 1½ and 2" sizes. Savings in materials are dramatic. This equipment pays for itself on the first good job.

2 More Speed on RIGID pipe, too!

The "Porto-Power" hydraulic unit has many exclusives. Because the ram works in *any* position, a Blackhawk Bender adapts to floor or bench use — or overhead on existing runs. Two models serve 8 pipe sizes, 1" to 4".



3 It's a Knock-Out Punch and it's HYDRAULIC!

No wrench to swing. "Porto-Power" punches holes up to 4½" in distribution boxes, etc. Saves at least 60% of job time.

4 Eliminate hand pumping!

A motorized, portable hydraulic pump (No. P-182) can *triple* the output of a pipe bender. It works wonders on other hydraulic equipment also.

5 Lift machinery, pull pulleys

Dozens of allied jobs are licked by the "Porto-Power" hydraulic jacks which serve Blackhawk Electrician's Equipment.

Savings in material costs and time are so large that it will pay you to get full facts on this low-cost equipment immediately. Send coupon for complete catalog. Buy from leading supply houses.

BLACKHAWK MFG. CO., Dept. P2071
Milwaukee 1, Wis.

Rush free Catalog No. 30B on Blackhawk Electrician's Equipment.

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BLACKHAWK

HYDRAULIC *Porto-Power* EQUIPMENT

IN NO OTHER BODY *Do You Get All This*

HUSKY, WIDE and HANDSOME

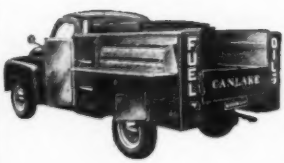
Carry-All's exclusive design and its extensive tooling and engineering make possible heavy gauge steel construction (with the correct gauge for each component) and a unique bridge-type underbody . . . these make possible huskier construction with lighter over-all weight and fewer number of parts *than any comparable body on the market* — that's why the MORRISON *Carry-All* has greater carrying capacity for gross vehicle ratings !

POSITIVE PROTECTION AGAINST WEATHER and THEFT

The center control dual latch locking arm effectively seals the double stamped and embossed door panels against the specially molded rubber gasket to make a completely weatherproof and weathertight closure. The forged chrome-plated handles are recessed for safety as well as appearance, and the entire mechanism is protected against theft by an individual cylinder positive action type lock on each door—keyed alike.

A DESIGN FOR EVERY ELECTRICAL JOB

The MORRISON *Carry-All* is designed for ready adaptation to any job . . . Morrison made provisions in the basic design for and has made available a selection of specialized accessories, so that the basic body can be easily adapted for any purpose in the electrical industry !



LOWER INITIAL COST — NO MAINTENANCE COST

Each dollar saved on your initial investment is matched by *lower depreciation and no maintenance costs* . . . the MORRISON *Carry-All's* die-stamped steel, electrically-welded construction is rugged enough to outlast two or three chassis and can be easily transferred from one chassis to another.

The MORRISON Carry-All is carried in stock for immediate delivery to franchised chassis dealers by 60 established truck equipment distributors from coast to coast.

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Carry-All Body Division
639 AMHERST ST. BUFFALO 7, N. Y.

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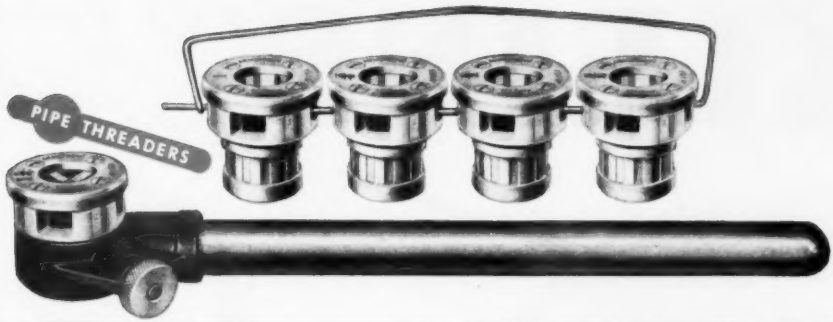

EVERY JOB GOES WELL *with* ARMSTRONG-BRIDGEPORT *Job-proved* PIPE FITTERS' TOOLS

A PRODUCT OF CAPEWELL

MORE WORK IN LESS TIME AND WITH LESS EFFORT WITH THE VOSPER DESIGNED PORTABLE PIPE THREADING MACHINE

The Papoose is a 2" heavy duty power pipe and bolt threading machine, for high speed pipe and bolt threading, cutting and reaming. It has quick opening adjustable die heads, high speed steel segments, and can cut 2" pipe nipples 2½" long without a nipple chuck. Portable and easy to handle, it can be wheeled right to the job.

THE CAPEWELL MANUFACTURING CO.
64 Governor Street, Hartford, Connecticut

Gentlemen: Please send me more information on

☐ Pipe Tools; ☐ Pipe Threading Machines.

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Top Quality

No. 201-NE

"Since 1857"

When it comes to judging the worth of pliers, ask the man who uses them every day. He'll tell you Kleins—for their hand fit—their proper balance—their carefully matched knives that stay keen longer.

The same top quality that typifies Klein pliers is also characteristic of other Klein tools and equipment—safety straps and belts, climbers, grips and wrenches. Men who know good tools have been choosing Kleins since 1857.

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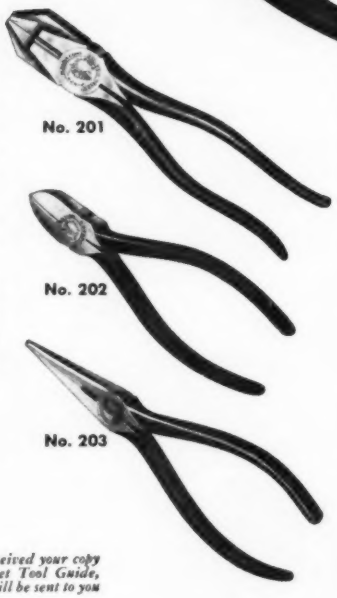
International Standard Electric Corp.
New York



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No. 203

If you have not received your copy of the Klein Pocket Tool Guide, write for one. It will be sent to you without obligation.

Since 1857

Mathias KLEIN & Sons
Established 1857 — Chicago, Ill., U.S.A.
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FOR SAFETY

the NEW ALLEN ground detector

Quickly detects and locates grounds in all wiring systems and equipment. It is the answer to the urgent and ever-increasing need for safety, *reduction of costs* of production, operation and maintenance of Industrial Plants.

NO SHUT-DOWNS NECESSARY

IT ELIMINATES:

INTERRUPTION OF PRODUCTION—
SHUTTING DOWN OF POWER—
DAMAGE TO PLANT EQUIPMENT

when used on isolated (ungrounded) power distribution systems.

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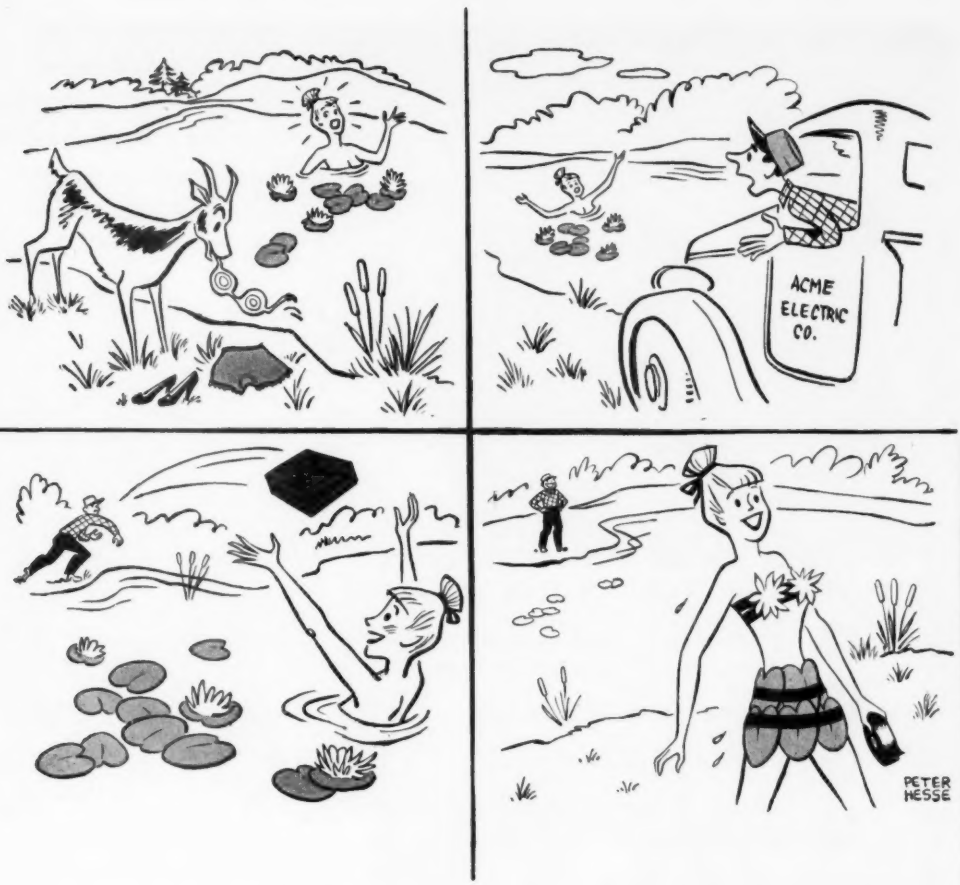
2125 S. WESTERN AVE. CHICAGO 8, ILL.



YOU CAN DO A LOT WITH A LITTLE JENKINS

Damp or dry . . . over uneven surfaces, Gold Seal tapes up tight. It's always "tacky" (adhesive compound is prepared under laboratory control), has high dielectric strength (less footage is needed per job), *goes further* (there's no waste). Gold Seal makes a hit with linemen and electricians because (1) it makes a tighter, longer-lasting bond, and (2) gives you more tape value in every roll. Ask your supplier for Gold Seal Tape, made by Jenkins Bros., (Rubber Div.), 100 Park Ave., New York.

Jenkins Bros. also make Diamond Seal Friction and Rubber Tapes which meet both ASTM and Federal specifications.

Gold Seal Tape

FRICTION and RUBBER TAPES

REG. U.S. PAT. OFF. JENKINS Jenkins Bros.

In either 10-roll cartons or single rolls. Every roll cellophane-wrapped.

FOR COMMUTATOR CONFIDENCE CHOOSE
KIRKWOOD

IN STOCK FROM COAST TO COAST
TO SPEED-UP YOUR MOTOR REPAIRS

- Engineered to stand up under extreme changes in vibration, heat, and speed
- Precision machined to fit right
- Made of the best material
- Choice of leading motor makers for lasting, trouble-free service

ALL TYPES • ALL SIZES

Use our catalog to specify or just send in old cores of bolt or nut type construction for refill.

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SAVE HOURS ON
CONDUIT AND PIPE
INSTALLATIONS

...with a GREENLEE PIPE BENDER

Cut costs, speed your jobs this efficient, easy, economical way. Make "on the job" bends in pipe and rigid conduit up to 5", thin-wall conduit and tubing with a GREENLEE Hydraulic Bender. One man operated for fast, accurate, uniform bending. Simple to operate, easy to set up and shift from job to job. Not only saves labor, but eliminates cost of many manufactured bends and fittings. Often pays for itself on first few jobs. Write today for free folder No. E-201.

TOOLS FOR CRAFTSMEN
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Other GREENLEE timesaving tools for industry: Hand Benders for tubing • Hydraulic Pipe Pushers Knockout Tools • Auger Bits and Drills • Spiral Screw Drivers • Chisels and Gouges • And many others. Greenlee Tool Co., 1747 Columbia Ave., Rockford, Ill.

Your logical SOURCE
—for all tape requirements!

Good workmanship in wiring calls for good materials. Make certain of tape quality by using the tape that's made with 30 years experience behind it!

ACCURATE TAPES

...for every INSULATING need!

ACCURATE RUBBER TAPE

Features high elasticity, excellent cohesion, high dielectric and super aging qualities. Available in Standard and A.S.T.M.-A.A.R. grades.

ACCURATE FRICTION TAPE

High grade rubber carefully compounded with finest cotton base provides maximum mechanical protection for every wrap. Made in Standard and A.S.T.M. grades.

ACCURATE Plastic Tape

Offers a bulk-reducing combination of thin caliper, good mechanical and dielectric strength. Recommended for use wherever plastic tape is practical.

...no finer tapes at any price!

For big wiring jobs or small, Accurate is the choice for positive tape protection. Both friction and rubber are strong, pliable, easy to apply. Accurate tapes make accurate wraps — pull tight and clean over irregular surfaces. When you order tape, mention Accurate by name. It's the one sure way to complete tape satisfaction. For a complete guide to tape selection and tape buying, ask for the new Accurate Data Folder. Accurate Mfg. Company, Garfield, New Jersey — address inquiries to Dept. B.

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OK!

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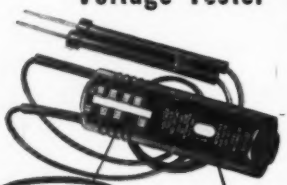
Safer, Faster, Lower Cost Electrical Maintenance

IDEAL

DOUBLE PROTECTION Voltage Tester



A SOLENOID VOLTAGE INDICATOR *and* A NEON TEST LAMP

Takes the danger, lost time and guesswork out of many kinds of testing. Not just a "glo" type. Solenoid indicator shows nominal line voltages on a calibrated scale. Neon test lamp operates independently — either will work if the other fails. Strong, dust-tight case protects working parts. Test prods are heavily insulated, with safety collar and 4-inch handles. Reliable and easy to use. Fits and *belongs* in every electrician's pocket!

FUSE CLIP CLAMPS

Save Up to 6% on Current Use!

Reduce resistance between clips and fuses or switch blades. IDEAL Clip Clamps eliminate power loss—arcing, burning or heating of wires and cables—conserve fuses and clips. Real maintenance reducers that pay for themselves and last a lifetime! Seven sizes, knife or ferrule type.

FUSE REDUCERS

No need to change switch, panel or switchboard. Should be used whenever new circuits are built with plans for future increase in power load; install larger fuses later. Snap into clip like ordinary fuse. Standard sizes for N.E.C. cartridge fuses. Knife or ferrule type.

Ideal Wiring Devices are Sold Through America's Leading Distributors

"Safe-T-Grip" FUSE PULLER

Never take a chance by pulling or replacing a cartridge fuse by hand! Play safe — use a "Safe-T-Grip". Gives you a full, positive grip that can't slip. Rugged, laminated fibre construction — high dielectric. The "standard" in many industrial and utility plants. Three sizes for small, medium and high-capacity fuses.

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IDEAL INDUSTRIES, Inc.
1041 Park Avenue, Sycamore, Illinois
Please send catalog data on:

- ☐ Voltage Tester
- ☐ "Safe-T-Grip" Fuse Puller
- ☐ Fuse Clip Clamps
- ☐ Fuse Reducers

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SAY "KEE-HAH-DAH"

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First With The Finest for 27 Years in Cutting & Threading Machines for PIPE • BOLTS • TUBING

QUIJADA "Chief" Portable Pipe & Bolt Threader. Patented automatic chucking. Range ½" to 2". By comparison, the fastest threader on the market.

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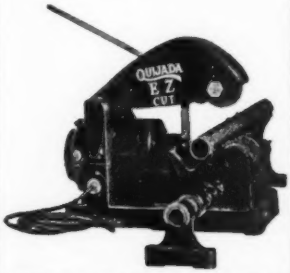
First With The Finest for 27 Years in Cutting & Threading Machines for PIPE • BOLTS • TUBING



QUIJADA "E-Z" Cutter. Capacity ⅜" to 4" pipe & tubing. Easiest, fastest & cleanest pipe & tube cutter ever designed.

Sold only through jobbers.
Write for complete information.

QUIJADA TOOL CO., Inc.
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America's most popular service body
used in every state in every service industry

POWERS
Service-Master
ALL PURPOSE SERVICE BODY

Absolutely weathertight compartment doors • Built-in trays, adjustable shelves and parts bins for orderly storage • Horizontal doors, when open give working surface on the job.

Fully enclosed wheel-housings provide added protection and rigidity • New recessed, positive action handles with flush locks • 48¼" inside width, more load space than a pick-up

Another typical Powers Service-Master application in service.

LOWER YOUR SERVICE COSTS WITH ONE-TRIP SERVICE!

Lost time is lost profit . . . so take your shop to the job in a Powers Service-Master body. The Service-Master is completely compartmentized and efficiently organized . . . increases the output of even your best service men. Take *all* your tools, parts, and supplies with you . . . speed up calls, reduce return trips. Electrically welded body is of all steel construction . . . comes completely assembled in one unit. Built to last many years . . . remountable on new chassis with only six body bolts. Cut down your service costs, increase your profits with Powers Service Master!

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Powers Service-Master bodies are carried in stock by Distributors in principal cities throughout the country.

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Please send me literature and further information about the POWERS "Service-Master" All Purpose Service Body.

Company.....

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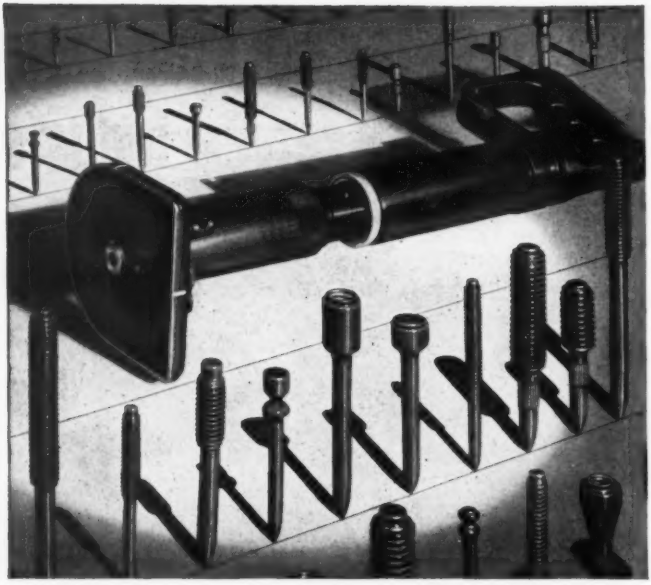

HOW TO SAVE 7 HOURS IN AN 8-HOUR DAY

You can do just this when you use high-speed RAMSET® SYSTEM for fastening almost anything into steel, concrete, other suitable materials, to install services, facilities and equipment.

That's because simple, self-powered RAMSET SYSTEM fastens up to 10 times as fast as ordinary methods. In *one hour* you can make as many fastenings as you can in a *whole day* with slow, laborious, drilling, chipping and plugging. Thus you . . .

1. **Finish the work faster**
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3. **Cut costs in proportion**

Let us arrange to do a sample job on your own work, without cost or obligation, to prove the important 3-way benefits which only RAMSET SYSTEM can give you. Call your local Ramset Specialist or write us for details.

Ramset Fasteners, Inc. 12117 Berea Road
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MEMBER OF PRODUCERS' COUNCIL

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Pioneer in powder-actuated fastening

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PRECISION INSTRUMENTS

For Plant Engineers

MEGOHMER

INSULATION TESTERS

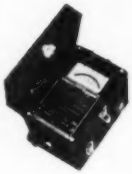
GENERATOR TYPES

"MINOR"
Dwarf Size: 3 lbs. with variable pressure DC Generator. 500 Volts D.C. Range: 0-10 or 0-20 or 0-50 Megohms. Bulletin 450.

"MAJOR"
DC Constant Pressure Generator 500 Volts. Range: 0-50 Megohms with Extra Ohm scale 0-30 or 0-10,000 ohms. Bulletin 465.

"STANDARD"
Heavy Duty Type
Constant pressure Generator 500 volts, or 1000 volts D.C. Ranges 200 megohms, 1000 megohms and 2000 megohms. Bulletin 455.

BATTERY VIBRATOR TYPES



MODEL B-7
Precision Ohmmeter-Megohmmeter. 2 Megohm Ranges: 0-20, 0-200 Megohms. 2 Ohm Ranges: 0-200, 0-20,000 Ohms. 2 Test Potentials: 250 and 500 Volts DC. Bulletin 440.

MODEL B-6
4 Instruments in 1. Insulation Tester: 0-200 Megohms. Ohmmeter: 0-2000 ohms. AC Voltmeter: 0-150/600 Volts. DC Voltmeter: 0-150/300 Volts. Bulletin 441.

TACHOMETERS

HAND TYPES
TYPE "U"
UNIVERSAL CENTRIFUGAL TYPE
5 Ranges in 1 Instrument

Cat. No. 303	30-12,000 RPM
Cat. No. 314	45-18,000 RPM
Cat. No. 322	60-24,000 RPM
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Bulletin 750

"JAQUET"
SPEED INDICATORS (CHRONOMETRIC)
Guaranteed Accuracy within ½ of 1%

Cat. No. 2301	0-10,000 RPM
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Suitable double rated speed. 3 models, various accessories.

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STATIONARY TYPE
MODEL "J"
Sizes 3", 4", 5½", 8", 10", and 20" dial diameter, flexible shaft driven.
Many standard ranges reading RPM, FPM, YPM, etc.

Bulletins 795, 796, 797

HERMAN H. STICHT CO., INC.
27 PARK PLACE — NEW YORK 7, N. Y.

DUTCH BRAND PLASTIX *Electrical tapes*

Regular .007 Plastix for general service or .010 Plastix for Heavy Duty

Available in practical sizes and packaging for contractors and industrial users.

The newest electrical tape in the line . . . High Dielectrical Resistance per mil of thickness . . . conforms readily to irregular surfaces. You'll find it an ideal tape for use in those many places where space is limited. **PLASTIX** stands up under severest conditions and resists water, oil, acids, alkalies and corrosive chemicals.

The new .010 **PLASTIX** Electrical Tape is slightly thicker for heavy duty work such as winding heavy cables, electrical harness or for use with power driven taping machines.

Both DUTCH BRAND **PLASTIX** ELECTRICAL TAPES are the result of careful study and research and meet the recognized high quality standards established by all other DUTCH BRAND electrical tapes.

For complete satisfaction order DUTCH BRAND **PLASTIX** ELECTRICAL TAPE by name . . . specifying either the regular .007 **PLASTIX** or heavy duty .010 **PLASTIX**.

The Three Electrical Tapes Friction—**PLASTIX**—Rubber to meet all requirements

REGULAR PLASTIX FEATURES THESE MANY OUTSTANDING QUALITIES

Tears Readily . . . in spite of its strength and stretch.

Conforms to Irregular Surfaces . . . great flexibility and stretch make excellent conformity.

Resists Weather . . . rain and rough weather do not affect it . . . favorably withstands relatively high or low temperatures.

Resists Oils, Acids, Alkalies, Corrosion . . . wherever present . . . in chemical plants, around machinery, etc.

High Dielectric Resistance, where space is limited . . . a single thickness resists 8000 volts which is greater than 1000 volts per mil of thickness.

Excellent Adhesion . . . the quality of the adhesive and the even coating assure excellent adhesion.

Tensile Strength . . . it is strong . . . has ample strength for all types of applications.

.010 PLASTIX ELECTRICAL TAPE CHARACTERISTICS

All general characteristics are the same as above except .010 PLASTIX is heavier gauge for heavy-duty work.

Thickness .010"
A single thickness resists 10,000 volts

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DUTCH BRAND

VAN CLEEF BROS. INC.
Manufacturers . . . Rubber Products . . . Est. 1910
CHICAGO 19, U. S. A.

MEET THE BEAVERETTES!!!

● If you have not yet met the **Beaverettes**, it's high time you were introduced, for these handy little self-contained threaders have been favorites for many years.

The Beaverettes are unique — there is nothing similar to them on the market.

Covering a useful range of pipe sizes from 1/4 to 3/4 inches, the Beaverettes are fully adjustable for cutting standard, oversize or undersize threads of uniform length.

Complete units, having no loose parts of any kind, these tools are accurately centered on the pipe by a smooth-working universal chuck.

Beaver No. 6 is a two-handle non-ratchet tool; the No. 6-R, a standard one-handle ratchet tool, suitable for either bench or confined-area use. Both models are available in either American or British standards, right or left hand, for threading 1/4, 3/8, 1/2 and 3/4 inch pipe. Extra changeable dies are available for 1/8 inch size.

Write Beaver Pipe Tools, Inc., 232-300 Dana Ave., Warren, Ohio, for new "Operating Guide" to help you secure the best possible results from your Portable Pipe & Bolt Machines and Hand Pipe Tools.

BEAVER PIPE TOOLS

3 Advantages!

- ✻ *LOW COST*
- ✻ *Makes High Pressure Connection*
- ✻ *Neat, Compact and Easy to Tape*

Ideal for taps or splices . . . Made in complete range of sizes from 1/0 to 1,000,000 CM . . . Heavy sturdy construction, yet compact and easy to tape...Will fit into close quarters . . . Produces very tight, high-pressure, trouble-free connection. For the best in quality at low cost, specify BLACKBURN.

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BLACKBURN Hi-Strength TWO-BOLT CLAMP

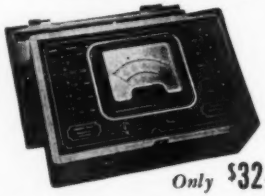
Jasper Blackburn Corporation
35 MADISON ST. ● ST. LOUIS 6, MO.
Phone CEntral 3007

TEST EQUIPMENT

for

Electrical Contractors, Maintenance and Repair Men

MODEL 247 **Industrial Analyzer**

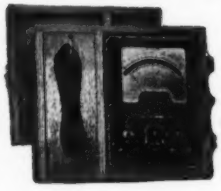


Only $32.50 NET

- Completely portable—No external source of current required.
- A special design, rugged current transformer is used for all current ranges.
- Measures VOLTS - WATTS* - AMPERES - RESISTANCE.
- Uses 4½" rugged meter with large easy-to-read type.
- All calibrations printed directly on meter.
  A.C. VOLTS 0 to 150/300/750 Volts
  A.C. CURRENT 0 to 3/7.5/15/30 Amperes
  RESISTANCE 0 to 20,000 ohms
  A.C. WATTS* 0 to 300/750/1500/3000 Watts—115 Volt line
  0 to 600/1500/3000/6000 Watts—230 Volt line
- Housed complete in beautiful hand rubbed oak cabinet with removable hinged cover.

Watts computed on the basis of Unity Power Factor

MODEL 460 **Insulation Tester**



Only $48.50 NET

4 Ranges:
0 to 200 ohms
0 to 20,000 ohms
0 to 2 megohms
0 to 200 megohms

Quickly and accurately measures insulation leakage from zero to 200 megohms at a test potential of 500 volts. The 500 Volt Potential is made instantly available by simply throwing toggle switch to "on" position. NO HAND CRANKING, built in power supply saves time and effort. A special LOW OHM RANGE (10 ohms center scale) reads as low as 1/10 of an ohm, making possible correct testing of coils, armature windings, etc.

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Drilling and Cutting in Concrete and Masonry with

SYNTRON

DEPENDABLE

ELECTRIC HAMMERS

Their 3600 powerful blows per minute make short work of drilling anchor bolt holes, in concrete and masonry—cutting and chipping holes in concrete and masonry walls and floors for pipe—scaling rust and residue in tanks and boilers.

They'll pay for themselves time and again on job after job in time and energy saved.

Only One Working Part—THE PISTON!

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SYNTRON COMPANY
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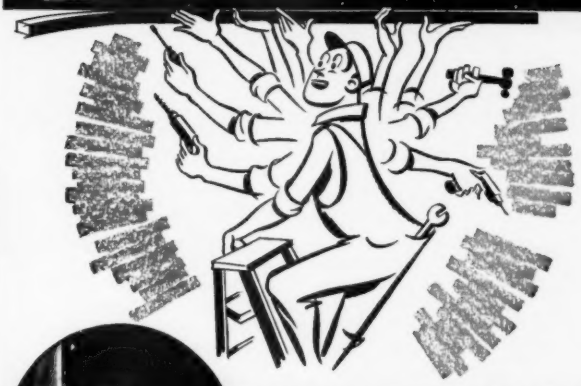
This fellow needs DRIVE-IT!



-and SO DO YOU for fastening steel or wood to concrete or steel . . .

Pity the man who is still using old-fashioned "dig and drill" methods for fastening steel or wood to concrete. He's wasting *his* time and *your* money.

DRIVE-IT powder-powered tools were designed especially to do such fastening jobs in a split-second—and at a great saving in time and money.

Now, especially, with help becoming harder to get, it will pay you to investigate the DRIVE-IT method of fastening. There's a tool for light work and one for heavy work—each approved by the Underwriters' Laboratories.

For the whole story on DRIVE-IT call your DRIVE-IT representative—or write us direct.

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THE POWDER POWER TOOL CORPORATION
0702 S. W. Woods Street, Portland 1, Oregon
Cleveland Branch: 2075 E. 65th St., Cleveland, Ohio
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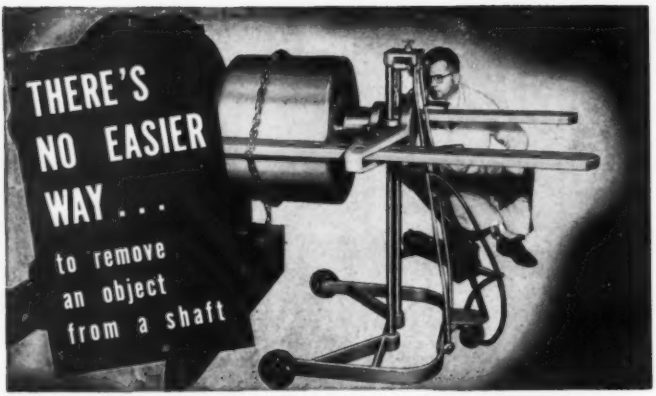
APPROVED BY UNDERWRITERS' LABORATORIES



5-ton size
$62.50
★
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$290.00
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$655.00
(F.O.B. Factory)

The New, Improved Hydraulic

PULLEY PULLER

Enables one man to remove a pulley, gear, pinion, or other object from a shaft in minutes! No crow bars, sledges, or blowtorches. No damage. Puller is adjustable, easily moved, rugged. Hundreds now in use in industry.

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122 - 124 E. 4th St. Davenport, Iowa

For Precision Cutting of Light Materials

THE *Jacques*
UNIVERSAL SHEAR

1. Laminated Steel Blade
2. Accurate Feed Gauging
3. Safety Holding Clamp
4. Adjustable Foot Pedal
5. In sizes 30" to 60"
6. Balanced Blade Holder
7. Receiver Gauge Adjustment
8. Receiver Gauge and Table
9. Welded Steel Rigid Base
10. Kiln-dried Birch Table

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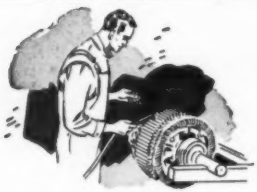
manufacturers of:
JACQUES Hand and Power Shears, Slitters and Rewinders, Paper Box Machinery, **TRI-POWER** Die Presses, **TOUCH-O-MATIC** Paper Cutters.



SOLDERING
HEATING
BRAZING

Prest-O-Lite 5-in-1 Precision-Control Outfit

Trade-Mark

Four stems and soldering copper cover every electrical job, from heavy soldering or heating to wire splicing or finest work on delicate instruments . . . Burns "Prest-O-Lite" Acetylene, from handy, small tanks, at automatically regulated, constant pressure . . . Needle valve flame adjustment . . . Full heat (2,800 deg. F.) instantly, without pumping, priming, or warmup . . . No smoke or fumes . . . Light and easy to handle.

Precision Model $22.50
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● Ask your jobber or write us for more details. Linde Air Products Company, a Division of Union Carbide and Carbon Corporation, 30 E. 42nd St., New York 17, N. Y.

The term "Prest-O-Lite" is a registered trade-mark of Union Carbide and Carbon Corporation.

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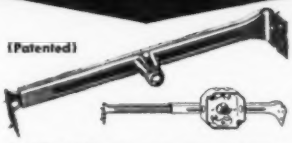
DO YOU KNOW THAT..

(Patented)



FAST•LOK (The original) adjustable BAR-HANGER with "SNAP-ON" stud was designed and developed by a contractor for progressive-minded contractors.

FAST•LOK Because of its immediate acceptance by the trade has already been imitated!

FAST•LOK Is nevertheless the *only* BAR-HANGER of its type that is honestly "TIME SAVING" in installation.

FAST•LOK Does not require disassembly and reassembly to fasten on the box.

FAST•LOK Only requires the removal of the knock-out in *any type* outlet box — "SNAP-ON" over the stud — That's all!

INSIST UPON FAST•LOK FOR FASTER INSTALLATIONS

The FAST•LOK MFG. CO.
BRIDGEPORT 5, CONNECTICUT
Sales Offices in All Principal Cities

"WOULD NOT SELL IT FOR TWICE THE PURCHASE PRICE"
Says Walter G. Kolb, President, Kolb Electric, Washington, D. C., of his first Up-Right Scaffold.

ONLY
Mobile Aluminum Alloy "UP-RIGHT" SCAFFOLDS *have*
BUILT-IN LEGS . . . INSTANTLY ADJUSTABLE
for rapid leveling on uneven floors or on stairways. Eliminates the cost of tedious screw leveling.

MOBILE TOWER SCAFFOLDS
up to 45' or higher assembled in 1 to 15 minutes.

PLUS OTHER

EXCLUSIVE FEATURES
That save time & increase profits

MOBILE TOWER SCAFFOLDS
In desired number of 6' or shorter section units.

1. Patented one-piece sections—no separate frames. Each section folds flat. No wrenches, wing nuts, bolts or loose parts.
2. Patented casters lock swivel and wheel as one.
3. Welded construction provides greater strength and safety.
4. One man assembly—each aluminum alloy section can be carried and assembled easily and safely by one man.

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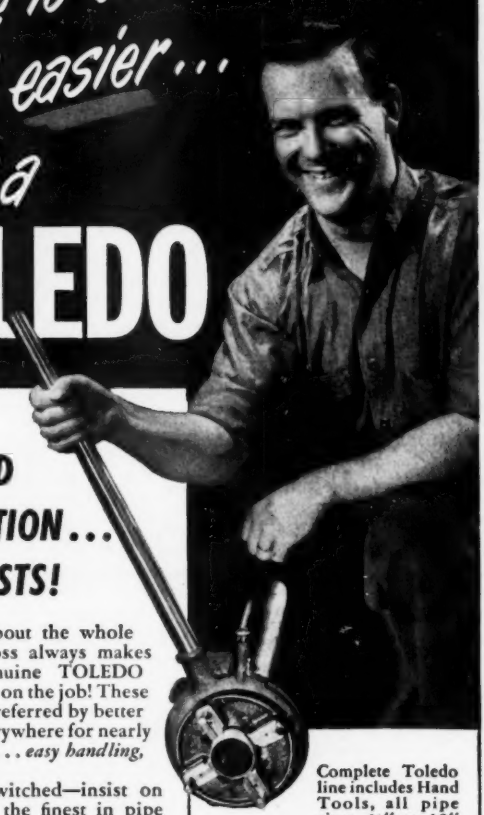
Before buying scaffolds insist on a demonstration—then buy the best—the one and only

"UP-RIGHT" SCAFFOLDS
Dept. 107, 1013 PARDEE ST. • BERKELEY, CAL.
Factories: BERKELEY, CALIF., & TETERBORO, N. J.
OFFICES IN ALL PRINCIPAL CITIES

Sure it threads faster and easier... it's a
TOLEDO

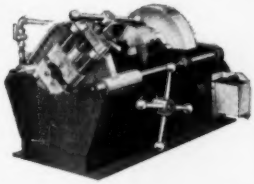


SPEED PRODUCTION... CUT COSTS!

He's happy about the whole set-up! His boss always makes sure that genuine TOLEDO Pipe Tools are on the job! These are the tools preferred by better mechanics everywhere for nearly half a century . . . *easy handling, faster cutting.*

Don't be switched—insist on TOLEDO for the finest in pipe threading and cutting tools and power machines! See how quickly Toledo dies take hold . . . how easily they cut smooth, accurate threads. Check the many advanced features of Toledo Pipe Tools . . . designed to speed the work and assure fast make-up and trouble-free joints. You'll be better satisfied with Toledo dependability! Write for catalog. The Toledo Pipe Threading Machine Co., Toledo, Ohio. New York Office: 165 Broadway, Room 1310.

Complete Toledo line includes Hand Tools, all pipe sizes, ⅛" to 12" and ¼" to 1" bolts. Power pipe machines, up to 2" and 4" capacity. (Above)—Toledo No. 1R Threader, 1" to 2" pipe.



Toledo #999 2" pipe machine, wheel or knife cut-off.

RELY ON THE LEADER

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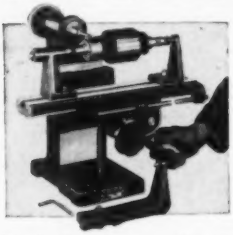
PIPE TOOLS . . . POWER PIPE MACHINES . . . POWER DRIVES

HULLHORST



Production Type — No. 10

MICA UNDERCUTTER

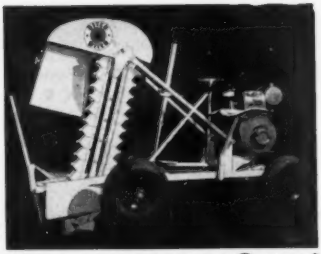
A machine for production, maintenance and service shops—undercuts up to 100 commutators per hour. This model has a capacity up to 5 H.P. D.C. Motors—any shaft length. Mounting for centered or centerless shafts. Spindle speeds from 2500 to 40,000 R.P.M. Use standard high speed steel saws or the new Tungsten Carbide saws.

Hullhorst Products Made Since 1920

HULLHORST TOOLS, INC.
1919 Nebraska Avenue
TOLEDO 7, OHIO

HULL-HORST
Maintenance Tools
ALSO AVAILABLE
a complete stock of saws for all makes as well as the following:

- Portable Mica Undercutter No. 10
- Improved Centerless Undercutter No. 15
- Mica Undercutter No. 7
- High Speed Mica Cutters
- Tungsten Carbide Saws



'DOES THE WORK OF 8 MEN'
— says enthusiastic user

Ditch-Witch

● Cuts a 5½" trench. Newest design — rugged, and extremely mobile. Powered by a heavy duty, air-cooled Wisconsin Engine. DITCH-WITCH pays for itself in a few weeks because first cost is low and operation is economical. DITCH-WITCH proved in various soils in all parts of United States.

Write — Wire Today
Sold Direct by Manufacturer

Ditch Witch
Made and Sold by
CHARLES MACHINE WORKS
PERRY, OKLAHOMA

HyKon

TIME AND LABOR SAVING EQUIPMENT

WIRE MEASURING EQUIPMENT

The unit SRM 18 shown is a complete wire measuring outfit. It consists of the STORE-ROOM REEL, WIRE METER and TAKE-UP REEL for neatly recoiling the wire after it is measured. This well constructed unit takes up little floor space—is portable and can easily be taken on the job. One man can handle all wire measuring jobs quickly—accurately.

Hykon "Reelift"

A quick, easy way to handle bulky, heavy cable reels. Just a simple lift on the handles and the reel sets up ready for unrolling the cable; pull back and reel is back down on the floor. The REELIFT will not tip when cable is being pulled off. The great leverage developed makes it easy for one man to handle 1,000-lb. reels. As reel revolves on an axle the REELIFT always does a job regardless of condition of reel.

WIRING REELS

Hykon Reels have eliminated many of the troubles encountered on wiring jobs and are saving time, labor and wire. Wire may be reeled off top or bottom from any angle without a kink or snarl. Correct tension is maintained so the Reels turn easily but never coast. All Reels are adjustable to different sizes of wire rolls.

WRITE FOR LITERATURE

HyKon MANUFACTURING CO.
STATION A
ALLIANCE, OHIO

UNEQUALLED

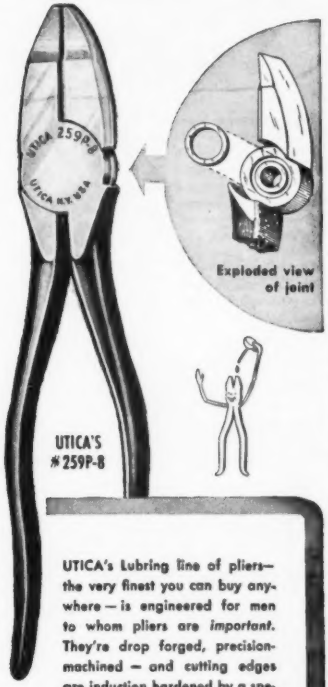
. . . FOR LASTING FRESHNESS

...users who KNOW buy only the BEST

Ask for them by name...

OKONITE and MANSON tapes

PLIERS THAT OIL THEMSELVES!



UTICA's Lubring line of pliers—the very finest you can buy anywhere—is engineered for men to whom pliers are *important*. They're drop forged, precision-machined—and cutting edges are induction hardened by a special UTICA process.

Each UTICA "Lubring" pliers has a ring of porous iron floating in the joint. This ring serves as a tiny reservoir for oil and releases it to the joint *as it's needed*.

In these days of limited replacements, why not make sure you get the long life and quality that go with UTICA?

UTICA Drop Forge & Tool Corp.
Utica 4, New York
In Canada:
Adlam Tool & Supply Co., Ltd., Montreal
Walls-Irons, Ltd., Winnipeg

It Pays To Use — U TI CA — Quality Tools

AND THE WORLD'S BEST TOOLS ARE MADE IN U. S. A.

The Jiffy Line

Established 1915
Is Sold By Leading Wholesalers

To Make More Profit Wire the Modern "Jiffy" Way

***Jiffy* Time and Money Saving Specialties help you do each job in the quickest, easiest and least costly way. That is why many contractors insist on "Jiffy"—no substitutes!**

Jiffy-LOCK Adjustable BAR HANGER
For old or new work. Fast, easy to use. No beams to notch. Adjusts 12" to 18" or 18" to 24".

Jiffy SNAP-IN BLANKS
One-piece seals snap into place, safely close knockouts at lowest cost. Six sizes, ½" to 2".

Jiffy SOLDER DIPPER
Swinging cup prevents spilling. Solders 50 to 75 joints with one heat. Lasts a lifetime.

Jiffy Clamp-in BOX SUPPORTS
Hold box firmly without screws or nails in any type wall. No more dropping holders behind partition.

Jiffy Porcelain WIRE CONNECTORS
Cast thread cuts into wire. UL-listed.

Jiffy Adjustable HOLE CUTTER
Easily used in any position to cut ¾" to 6" perfectly round holes quickly and accurately in steel boxes, plates or panels.

Jiffy Drill Press CUTTER
Adjustable for cutting ¾" to 6" perfect round holes.

Jiffy Green Dot OUTLET PROTECTOR
Keeps box clean, free from plaster. Green stem locates plaster - covered box. Saves hours on the job. Re-usable.

Jiffy No-Kink Fish TAPE
Easiest to use in any conduit. Will not kink or break. No reel needed. Lengths, 25, 50, 100 feet.

Jiffy CONDUIT BENDER
½" and ¾" conduit can be cut, threaded and formed without removal from this vise.

Write for latest catalog and cost data.

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Phone TAylor 9-1144

LINDELL
BORING ATTACHMENT

FASTER, EASIER BORING

FITS ANY ½" ELECTRIC DRILL

The Model 30 Lindell Drill Attachment permits easy boring in tight, hard-to-reach places. Bores holes straight through joists or studdings. Four-foot shaft allows boring overhead or below without adjusting. Reduced speed for more power. Conserve your time and labor with the low cost Lindell Drill Attachment. Also available is Model 32, a complete unit including an all purpose, easily detachable ½" electric drill.

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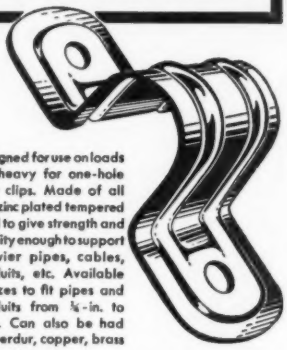

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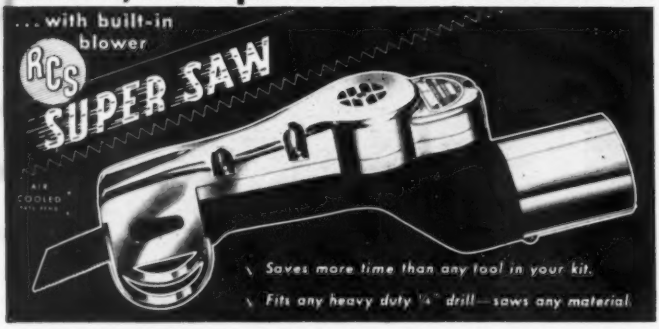
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SUPER SAW
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Saves more time than any tool in your kit.
Fits any heavy duty ¼" drill—saws any material.

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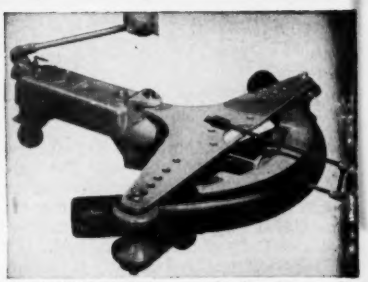

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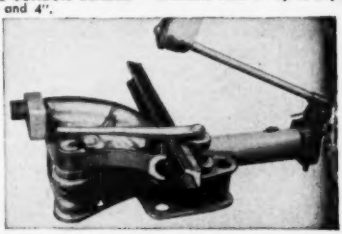

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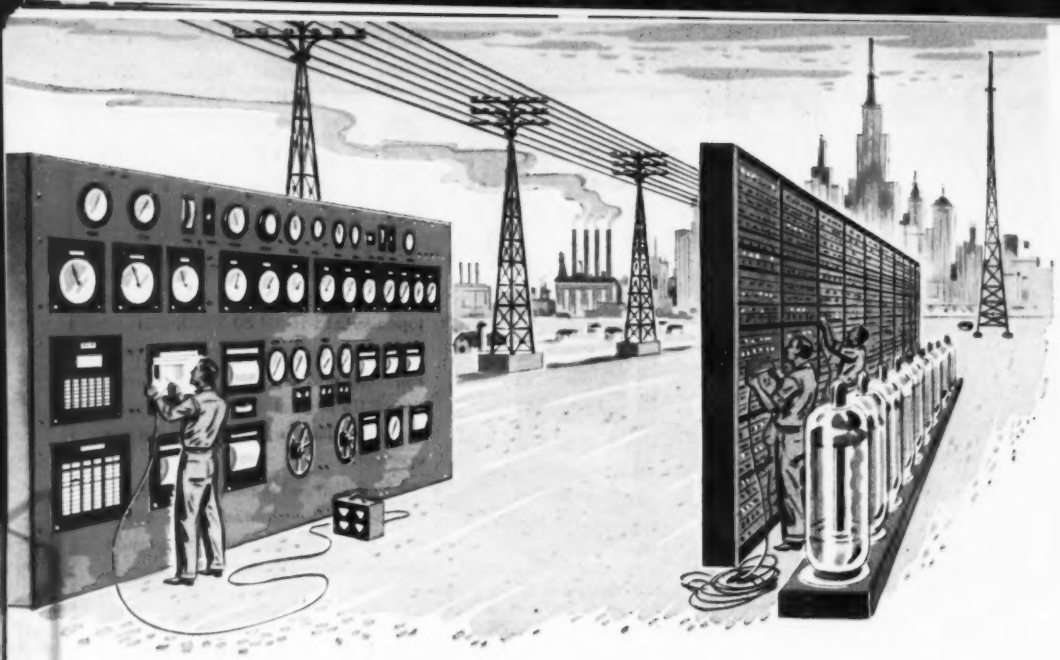


Preventive Maintenance

ELECTRICAL systems and electrical apparatus are inherently trouble-free. Through design, skillful installation, circuit protection, and relative freedom from complex mechanical movements, failures are notably infrequent in view of the large values and complexities of the systems involved.

As electrical systems grow, however, routine care becomes imperative. Normal wear and tear must eventually be repaired. Bearings need lubrication. Contact surfaces subject to severe use must be restored. Lamps need replacement. Such chores, neglected or unscheduled, become increasingly costly and troublesome as systems become more elaborate.

At the mid-century frontier, maintenance trends are toward preventive schedules and methods. Alert inspection and periodic routines keep ahead of breakdown. By anticipating failures through critical instrument analysis, repairs are initiated on normal down time. By scheduled cleaning and lamp replacement, levels of illumination are maintained at design values.

The function of preventive electrical maintenance goes beyond the preservation of the electrical system. It avoids the costs of unscheduled shutdown in production and interruptions in critical processes.

Emergencies can and do occur under the best of preventive maintenance programs, but scheduled system care holds them to a minimum. In some plants, emergency repairs are carried out by specially trained crews without interfering with routine maintenance operations.

As electrical systems grow more complex, as apparatus in greater quantity and variety are added, the role of preventive maintenance will take on larger responsibilities in the years ahead.

PREVENTIVE

CARD FILES containing data on all material or equipment in the plant, together with lists of suppliers, delivery schedules, prices and discounts, are essential. Essential data on motor rewind shops and electrical contractors should also be filed for cases when outside help is required.

PERPETUAL INVENTORIES maintain constantly-accurate stock records of maintenance equipment and materials. Alphabetical card files on rotating drums recessed into desk top aid purchasing agents in quickly checking any item in question.

Organization and Administration

Budgeted maintenance is an investment in efficiency, safety, dependability; designed to conserve manpower, manhours, materials. Here are guides to current trends.

THE problem of maintenance is growing. That is true in small and large plants alike. And this problem will continue to grow for five reasons:

1) Physical facilities must be kept in good repair to produce products of high quality at maximum speed on rigid schedules and at minimum cost to meet competition and return a fair profit.

2) Manpower, man-hours and materials must be conserved.

3) The life of increasingly expensive and hard-to-get equipment must be prolonged for reasons of economy and conservation.

4) The widening scope of electrical operation is demanding greater maintenance know-how.

5) The permissible cost of maintenance must be aligned with economics of prudent management.

Due to this last-mentioned point, many smaller plants argue that, "We believe in preventive maintenance but are not large enough to afford it". The reverse is actually the case for no plant can afford improper operation of equipment, shutdowns, delayed production schedules, idle labor or accidents due to hit-or-miss repair methods.

Preventive maintenance costs money. So does neglect—only more so. That is particularly true during periods of inflation, allocations, delayed shipments due to transportation problems, stockpiling and manpower shortages such as we are now again experiencing. Now more than ever, breakdowns, excessive deterioration and delays caused by improperly-maintained equipment are costly.

Costly as it is, preventive maintenance is essential. And this calls for planned shutdowns, scheduled inspections, accurate records, adequate inventories of replacement parts, availability of proper tools and instruments—and trained personnel.

Many such programs exist. They have a common objective but vary widely in scope and methods. These variations, however, are unimportant. What is important is the fact that the need is recognized and many programs do exist. Formerly practiced piecemeal in relatively few plants, preventive maintenance is now recognized as a major factor contributing to production. It is as important as engineering, selection of equipment, installation and operation.

Whether a maintenance program is a one-man small-shop assignment or a large-plant departmentalized function, it is essential that an over-all plan of organization and administration be adopted (1) to designate responsibility to individuals, (2) prepare accurate records and (3) analyze inspection and repair reports.

Designation of responsibility is the basic framework of a maintenance organization. And, whenever the size of a plant warrants the employment of

MAINTENANCE

ELECTRICAL PLANS and wiring diagrams eliminate uncertainty when identifying feeders and branch circuits for test purposes, system expansion or revamping. When kept in cardboard mailing tubes, plans can be stored compactly in shallow filing closets.

ROTATING STOCK BINS occupy little floor space yet hold many items necessary to plant maintenance. Since each round shelf is partitioned to hold several items, and since the shelves can be rotated easily, several dozen items can be conveniently stored within a few square feet of area.

several maintenance men, specialization should be emphasized. In this way, proficiency is higher, service is quicker, results are more positive.

Heading a maintenance organization is the engineer or chief electrician. He is responsible for selecting equipment, maintaining supplies of spare parts and materials, engineering system changes, scheduling and supervising the maintenance of all electrical equipment. Depending upon the size of the plant, he may be aided by assistants (for day or night duty) and by a clerk or secretary.

Supervisory personnel include foreman and crew leaders. Their responsibility can be by equipment classification (such as motors, lighting, controls, distribution) or by area (such as manufacturing, assembly, shipping, office).

Paper work, though frequently considered a time-consuming chore, is definitely valuable. It can be resolved into five categories:

1) Layout plans and wiring diagrams,
2) Motor records and case histories,
3) Test data secured on inspection trips and system surveys,
4) Inventories of repair, replacement parts,
5) Cost records compiled from work orders and job reports.

Plans and diagrams eliminate uncertainty when identifying feeders and circuits for test purposes, for revamping or extending the system, and for making system surveys.

Motor histories, recorded and filed on separate cards, provide invaluable finger-tip information. Careful analysis of these cards frequently reveal patterns of repetitive faults, suggesting revisions in the scope of maintenance practices, changes in motor applications or alterations of control methods. Through such histories it is possible to set up schedules for contemplated replacements, thus anticipating and eliminating ultimate breakdowns. It is often possible to determine whether breakdowns are caused by improper installation, improper operation or faulty materials.

Test data, secured with the aid of instruments, should be studied to check loading conditions, operating characteristics, voltage drop, power factors, adequacy, efficiency and safety.

Inventories of repair and replacement parts are determined by past experiences, the number of shutdowns over a given period, and the amount of repair work required each time. As the number of units to be serviced increases, stocks can be safely cut percentagewise. Inventories are further dependent upon availability of parts, normal delivery periods, possibility of salvage or repair of damaged parts.

Cost records are important to determine the number of hours and quantities of parts employed for testing, checking, cleaning, making minor repairs and adjustments. Emergency work should be recorded separately so that future work of a similar nature can be estimated accurately. System extensions and alterations should also be kept separate.

The maintenance trend is growing rapidly, because it is increasingly evident to management that money budgeted for preventive operations is money invested in economy, efficiency, safety and dependability. The number of plants with separate maintenance departments is steadily increasing. And profitable plus business is going to electrical contractors and motor repair shops that recognize and promote the importance of contract maintenance.

BEVELING BRUSHES to a good fit with the commutator is essential whenever new brushes are installed. Sanding should be followed by careful blowing or wiping to remove all particles of sand.

UNDERCUTTING high mica with motor-driven flexible-shaft unit is a maintenance procedure recommended for reducing high-frequency chatter, sparking, copper picking, or for excessive wear.

Motor Maintenance

ELECTRIC motors—"work horses of industry"—render tremendous service with a minimum of attention. They do not demand extraordinary care to keep them operating effectively, but wear, abuse, misapplication and unavoidably tough operating conditions do lead to breakdowns when preventive maintenance is not adopted and practiced.

Motor maintenance is simplified by the fact that 90% of all motor failures can be traced to four basic causes: dirt, moisture, friction and vibration. The remaining 10% are damaged by misalignment, improper loading, and oil—improperly placed.

A program planned to eliminate or reduce these causes consists of five basic procedures.

1) Shutdowns should be scheduled, so that their inaction does not inconvenience or disrupt normal operations. Therefore, when it is known that a motor will be out of service, the electrical department should be notified so that maintenance can be arranged to coincide with planned shutdown.

2) Units, parts and sub-assemblies should be stocked so that quick changes can be effected.

3) Parts and spare units should be kept dry, clean and in ready-to-use-condition.

4) Records of motors should be kept accurately, because a listing of symptoms, causes and remedies of similar previous repairs often forms a pattern which can determine future maintenance practices.

5) Inspections should be adhered to as regularly and thoroughly as circumstances permit.

Where motors are adequately protected—as is the case with enclosed, splash-proof and explosion-proof units—maintenance can be reduced. For this reason, many companies install such motors even when their use is not absolutely essential.

Open motors, however, call for frequent cleaning of bearings, replacement of gaskets and dust seals, and the cleaning of windings, commutators, housings and slip rings.

Blowing dirt from windings, with compressed air at about 40 psi, is one way of cleaning. Another method is by vacuum.

Tough conditions—where dust and grease have coagulated into hard coatings—call for the use of solvents, but care should be taken to (1) protect the body of the insulating varnish against strong vehicles and (2) provide adequate ventilation when using dangerous liquids such as carbon tetrachloride.

That brings up the second cause for motor failure—moisture—for a gummy mass cannot be formed without it. Gum absorbs acids, softens windings.

Moisture can be minimized by maintaining motor dryness. That means keeping condensation low and evaporation high. One way is to run standby motors briefly every few days, creating internal heat. Another way is to promote the circulation of air, for evaporation can be speeded by the movement of air—either natural or forced.

When insulation tests indicate that moisture has been absorbed, windings can be dried by baking at

about 220-degrees F; by blowing warm dry air through resistors or steam coils into the windings; by locking the armature and applying low-voltage current to the circuit to create internal heat, or by covering the motor with a tarpaulin and placing several incandescent lamps beneath it. Large motors can also be kept dry by providing strip heaters near them, with automatic controls placing them in operation when the motors are shut down.

Friction—the third cause of failure—calls for proper lubrication. The word proper should be stressed, for oil and grease should be used as directed by the manufacturers.

Vibration—the last of the four failure forces—can crystallize metallic connections, break electrical connections, shake parts loose and aggravate normal wear.

Weekly inspections should include:

1) Oil gages; stopping the motor to check the level when the journal size is less than 2 inches.

2) Ball or roller bearings; checking for evidence of vibration or creepage of grease on the inside of the motor or generator.

3) Brushes and commutator or rings; looking for sparking, discoloration or roughness of commutator surfaces, wear of brushes, loose connections.

4) Rotors and armatures; checking air gaps on sleeve-bearing motors.

5) Windings; cleaning by suction or mild blowing if necessary, wiping with a dry cloth, noting evidence of moisture, checking for signs of grease or oil.

6) Mechanical conditions; such as unusual noises (such as metal-to-metal), unusual odors (such as scorched insulating varnish), tension of belts, wear of gears, clearance of chains.

7) General environs; looking for dripping water, acid fumes, lint or chips, clogged ventilation ports.

Monthly inspections should include:

1) Windings; checking shunt, series and commutator fields for tightness, also checking tightness of machine cable connections.

2) Brushes; noting spring pressure, the fit and play of brushes in holders, replacing badly worn brushes, checking brushes for chips and heat cracks.

3) Commutators; examining surface for high bars or high mica, looking for evidence of roughness.

4) Enclosed gears; draining the oil and looking for presence of metal scale, sand or water.

5) Connected loads; to check for changing conditions, poor adjustment or control.

Yearly inspections should include:

1) Windings; checking insulation resistance, surface cracks, accumulations of dust and gum.

2) Bearings; renewing waste—and wick-oiled packing if they have become filled with dirt.

3) Rotors (wound); cleaning thoroughly around collector rings, washers and connections, tightening connections, checking tightness of wedges and smoothness of rings.

4) Rotors (squirrel cage); checking for loose or broken bars, evidence of local heating, loose blades, worn bearings.

5) Armatures; cleaning air passages, checking commutators for surface conditions, high bars, high mica or eccentricity.

6) Loads; taking instrument readings at no load, full load, complete cycle—as a check on the mechanical conditions of the driven machine.

7) Mechanical parts; checking belts and chains for breaks or damage, cleaning inside of end bells and frames, turning rotor by hand.

METERS and instruments—industry's stethoscopes—take the guess work out of analysis. And only by knowing voltage, current, speed, torque and insulation resistance can motors be intelligently maintained and efficiently utilized.

DYNAMICALLY BALANCING all rotating parts accurately locates uneven distribution of weight, making it possible to accurately and inexpensively correct the condition, thus reducing vibration, wear and the ultimate destruction of bearings.

COMPRESSED AIR at about 40 psi blows dirt from windings and insulation. Vacuum cleaning is also desirable, since dust is then taken from the air as well as from the equipment, and the possibility of blowing insulation loose is eliminated.

POINTS OF CONTACT between stationary and movable tips are points of high resistance. On maintenance tours, these points should be checked for pitting or oxidation, using a file with discretion to remedy either condition.

LOOSE CONNECTIONS may result from vibration, changes in temperatures, tension on wires or careless installation, so tightness of nuts, bolts and screws should be checked regularly. Accessibility of control is essential for speed and safety.

Control Maintenance

CONTROL equipment is no exception to the rule that preventive maintenance is essential for peak efficiency. Since controls frequently operate hundreds of times a day, it is particularly important to locate and repair potential trouble before breakdowns occur. This is possible only through regular inspection, adjustment and replacement of worn or damaged parts.

Since judicious selection has a direct bearing on ultimate maintenance requirements, serious consideration can be given to front vs rear connections, copper vs silver contacts, or dust tight vs open construction. Important as these points are, however, controls should be selected to satisfy six basic questions. 1) Will it perform the service for which it is intended? 2) Is it simple to install, operate and maintain? If not, are the possible complications justified by improved service or reliability? 3) Will it be conveniently located for cleaning, adjustment or repair without disturbing production or endangering the maintenance man? 4) Is it available, with standard replacement parts and standard maintenance methods? 5) Is it backed by a supplier giving reliable service, prompt investigation of faults, fast replacement of parts, dependable engineering and accurate operational data? And 6, what is the expected life of the control?

Industrial controls cover a wide range of magnet-operated devices (relays, brakes, contactors, solenoids), thermally-operated devices (thermostats, overload and temperature relays), motor-operated devices (rheostats, thrustors, timers, valves, brakes), mechanically-operated devices (switches, controllers, pushbuttons, rheostats) and certain static accessories such as rectifiers, capacitors, transformers, fuses and resistors. Each group calls for maintenance on a scheduled, check-list basis. Magnet, thermal and motor operated devices should be inspected monthly; mechanically-operated controls and static accessories at least twice a year.

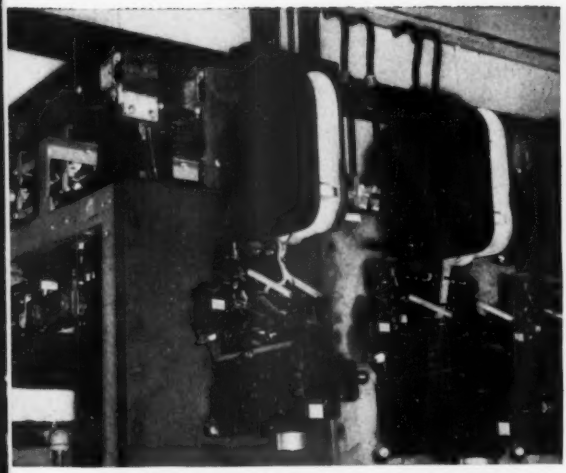
On these inspections, all operating devices should be checked for:

Collection of dirt and gum
Corrosion of metal parts
Worn or broken mechanical parts
Evidence of liquid dripping or splashing on the controls
Excessive arcing in opening circuits
Freedom of moving parts without sticking or binding
Proper contact pressure
Condition of flexible shunts
Excessive heating of parts—evidenced by charred insulation or discoloration
Loose connections

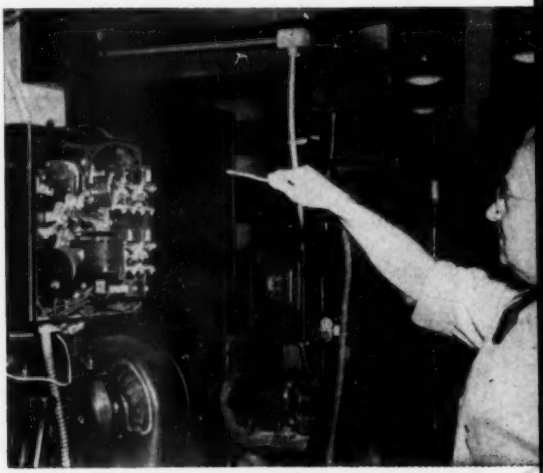
In addition to this basic check-list, **magnet-operated** devices should be simultaneously checked for:

Control circuit voltage
Condition and level of oil if devices are oil immersed
Condition of gaskets
Functioning of sequence and timing devices
Remaining wear on contacts
Condition of arc chutes or barriers
Condition of brake wheels and linings
Excessive ac magnet noise.

Thermal-operated devices should be checked for the basic list plus:



ARC CHUTES should be replaced if severely burned. to prevent flashovers from shorting the adjacent phases or burning the pole pieces. Flexible shunts should be flexed or twisted to check for broken strands or evidence of corrosion.



FREQUENT BLOWING with clean dry air at about 50-psi pressure is generally effective in preventing the accumulation of dust and the formation of gum, although wiping or washing the controls with a suitable cleaning fluid is often necessary.

Condition of heating elements

Operation of contacts when latching mechanism is tripped

Condition of control-circuit contacts.

Motor-operated devices call for the basic inspection, the first four special items mentioned in the magnet-operated category, plus:

Excessive vibration and noise

Wear or roughness of sliding contacts

Condition of gears.

Mechanically-operated devices, in addition to the basic check-list, should be inspected every six months for:

Condition of barriers or arc chutes

Condition of gaskets and oil

Condition of control-circuit contacts

Wear or roughness of sliding contacts.

Static accessories should be inspected for evidence of dirt or gum, evidence of excessive heating, corrosion of the metal parts, and loose connections.

By preparing pocket-sized card check-lists for each piece or group of control apparatus, inspecting electricians can carry these reminders on their rounds, can make notes of unusual conditions found and, if these notes follow a pattern of repetition from one inspection to the next, a thorough test should be planned to find the cause of the repeated condition.

Control contacts are of four basic materials; each one having certain merits, purposes and maintenance requirements.

By far the most commonly used contact is *copper*. It can be readily formed into desired shapes and has high thermal and electrical conductivity. Objections to copper are the tendency to oxidize (raising temperatures), the tendency to stick or freeze under certain conditions, and the comparative softness of the metal which reduces resistance to abrasion and mechanical wear. Maintenance of copper contacts should include the adjustment of spring tension, removal of oxide and filing of large burrs. Contact tips should be free of oil, because the resultant burning of the oil will raise the temperature and shorten the life of the tip.

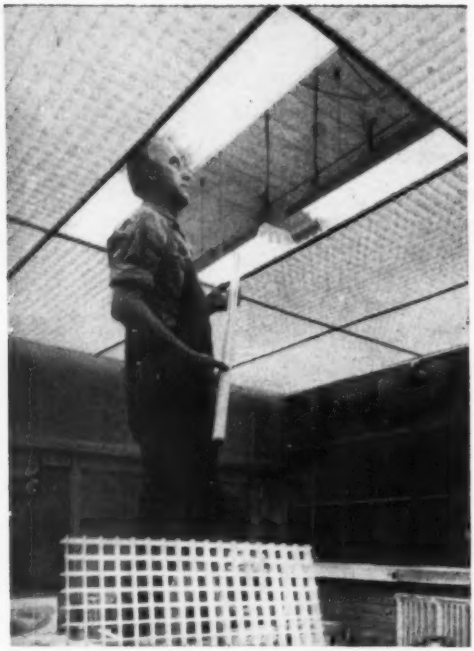
Where arcing is not severe (contacts remaining closed for long periods) and where oxidation makes copper unsuitable, *silver* contacts are used. While it is true that silver also oxidizes, the process is slower and the coating can be readily removed by mechanical action. Silver has the disadvantage of softness, reducing the resistance to mechanical wear. The use of silver is generally limited to small contactors up to about 25 amps capacity and small relays. In maintaining silver contacts, filing to remove oxide films should be minimized in order to prolong the life of the usually-thin silver tip.

While all metallic contacts have some tendency to freeze or stick, (only materials such as carbon being purely weld-free), there are several so-called *weld-resistant contacts* in use. These are usually limited in use, however, because of higher cost; difficulty to mount, form or rivet; higher resistance and heating; short life or aggravated arcing.

Where contact pressures, voltages and mechanical actions are of a low order, special materials are used for *sensitive operation*. Such materials, including rhodium, platinum and gold, require special consideration and should be maintained in accordance with manufacturers' recommendations.

Chutes and Shunts

While checking the condition of contacts, it is also well to inspect arc chutes, flexible shunts, interlocks and gaskets. In this connection, if arc chutes or barriers are nearly burned through, they should be replaced to prevent the heat from the arc from shorting the adjacent phase or burning the pole pieces. Flexible shunts can be twisted or flexed to test their condition. Interlocks should be adjusted in accordance with prescribed instructions, and gaskets should be replaced if torn or damaged.



ACCESSIBILITY is an important factor in an efficient maintenance program. Louvers should be easily removable and starters should not be blocked by lamps or wiring covers.

LOW VOLTAGE between sockets can be checked with voltmeter and test probes. Drops in voltage (due to overload, inadequate wiring or poor regulation) will reduce output.

Lighting Maintenance

LIGHTING systems are installed in industrial plants to provide efficient and comfortable seeing so that workers can perform visual tasks quickly, accurately, safely and comfortably with minimum fatigue and strain. When lighting systems deliver the quality and quantity of light for which they are designed, they are good investments—paying dividends in increased efficiency, lower operating costs, higher employee morale and fewer accidents. Conversely, when light fails to reach working areas, dividends are slashed—for *lost light costs just as much per footcandle as useful illumination.*

Lost light can result in only one of two conditions: the inadequacy of the system as designed, or the necessary installation of a system deliberately oversized to compensate for the expected losses.

Adequate light, therefore, can be secured by two methods: by paying for additional fixtures, wire, controls, lamps and current—or eliminating the losses through *preventive maintenance.*

Fortunately for maintenance simplicity, the causes of lost light are few; six causes accounting for over 90% of the known losses. These causes are 1) lamp aging, 2) low voltage, 3) luminaire inefficiency, 4) reflectance of room surfaces, 5) dirt and dust, and 6) lamp outages. These causes indicate the importance of careful selection of equipment, adequate wiring, maintained high power factors, periodic inspection, painting and washing, testing and relamping.

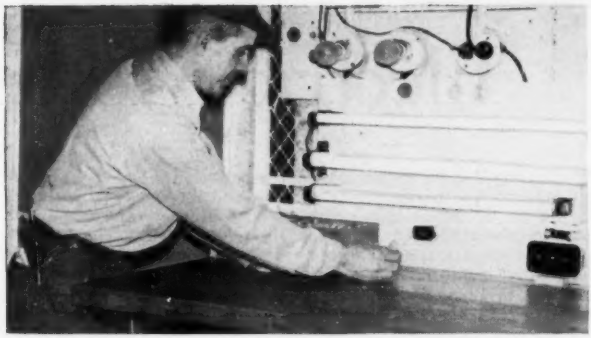
The wisdom of burning lamps until they fail has long been debunked. For example; with fluorescent systems it is economical to schedule replacements at around 80% of the rated lamp life, thus preventing outages with incurred extra replacement trips, also weeding out lamps that have become so darkened that the cost for the wasted current outweighs the cost of new lamps.

Scheduled group replacements need not disturb normal production routines, for they can be scheduled for night shifts, weekends or other customary down periods.

Cleaning of lamps and fixtures—using plenty of water and a good detergent—is necessary in all plants for, even in windowless factories circulating filtered and conditioned air, dirt and dust accumulations can cut light output 20% or 30% over a 5- or 6-month period. In unusually dirty locations, such as above high-speed metropolitan newspaper presses, ink vapors can reduce light output nearly to zero during a single press run.

Many plants schedule their cleaning functions on a continuous-cycle basis, the number of workers

DIRT AND DUST, major causes of lost light, are removed by washing with water and detergents. Maintenance men work in twos.



LAMP STARTERS are checked by inserting into a test-board socket, noting time intervals before good lamps cut in, and whether or not no-blink manual-reset units automatically cut out when connected with faulty lamps.

SLIMLINE LAMPS with single pins, installed in fixtures having hinged louver sections, are easily installed by one man. Longer lamps result in fewer fixtures to maintain; simplified wiring.

so employed determined by the size of the plant, number of fixtures and rate of light depreciation.

Lighting assemblies should also be frequently checked for bad ballasts, broken sockets, grounds, improper wiring and between-socket voltage.

While maintenance is generally considered as a service to be practiced after equipment is installed, maintenance efficiency can be promoted by careful initial selection of fixtures. This is apparent by recognizing the wide differences in fixture design and construction; some details making it necessary to remove louvers, lamps and/or wiring covers to reset or replace starters, or removing louvers and side panels before replacing lamps. Using single-pin fluorescent lamps can also reduce maintenance procedures, and using fewer but longer lamps can contribute to maintenance efficiency.

The importance of lighting maintenance is emphasized by the fact that lumen output can be reduced 30% during the rated life of a lamp due to normal depreciation. Low voltage, due to overloaded circuits, long runs and undersized wiring can account for light losses up to 20% in extreme cases. Inefficient luminaire design can reduce lumen output by as much as 35%. Painted surfaces of walls, ceilings and equipment lose their reflectance at the rate of about 5% a year. Accumulated dust and dirt frequently cuts light output by as much as 20% to 30%. And lamp outages have been responsible for a 12% light loss in plants not subscribing to a maintenance plan.

Lamp aging is unavoidable, but it has been pointed out that it is more economical to replace a lamp before it has reached its rated life than to burn it until it fails. Luminaire inefficiencies can be reduced by intelligent analysis at the time of initial purchase and installation. The remaining lost light can be reduced by correction of causes.

Electric Motor Repair

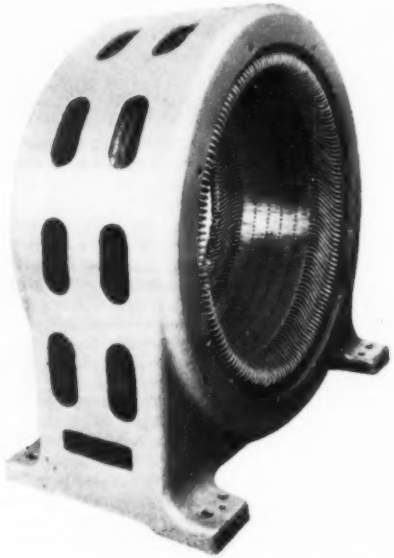
THE repair industry plays an important role in the industrial activities of our country, and is essential in modernization programs and preventive maintenance plans. Advance in science, development of new products and materials, and enormous expansion of manufacturing facilities have all contributed to the advancements made in the repair industry.

Fifty years ago, the electric service shop, an important member of the repair family today, with some exceptions, was a small business. Great progress has been made since those pioneering days at the dawn of the twentieth century. Today most of the electric repair shops are vigorous and sound businesses, employing modern methods equal to those in any other business.

Analysis shows that the onward march in electric shops has been due to the following factors:

1. New materials and new processes.
2. Better equipment and better methods.
3. Use of engineering principles and practices to an extent never employed before.
4. Organization of National Industrial Service Association, devoted to betterment of performance of independent shops.

Scientists created and engineers developed many materials and products which are used in repair shops today. Most important was the introduction of many new insulating materials and radical evolution of old ones into new shapes and forms.



QUALITY SHOP WORK restores mechanical and electrical characteristics to original values.

For example, let us take the new types of magnet wires. These wires are produced in round, square, rectangular and ribbon forms and come with different types of coverings like: enamel, cotton, cotton and enamel, silk, paper, enamel and paper, paper and cotton, silk and cotton, cellulose-acetate, artificial silk, asbestos, formvar or formex, nylon, fiberglass, silicone, and others. All these wires find application in the electric shop. In the selection of wire insulation, these factors must be considered: the space factor, which signifies compactness of a wire, (high space factor is usually desirable); dielectric strength, cushion effect, resistance to temperature, ease of working into desirable shapes, absorption of impregnants, resistance to solvents, mechanical strength, ease of stripping, cost, and finally (important today), availability.

Cotton covered wires are used in applications where the amount of space occupied by cotton is small in comparison with the size of copper. Space factor is relatively low. This wire provides good cushion and absorbing insulation. Silk is used on finer sizes of magnet wires, because of its higher space factor as compared with cotton, but it is more apt to be subjected to deteriorating effects of high temperature. Enameled, heavy enameled and formex insulated magnet wires possess many desirable characteristics: high space factor, high dielectric strength, uniform film thickness, and good resistance to heat and oil. Formex wire is covered with polyvinyl-acetal, and its features are similar to but better than enameled wire. Nylon resins have the good qualities of formex wire and are also insoluble and present no possibility of solvent crazing. Some combinations of these two components, made up of successive and alternative coatings of nylon and formex, result in a type of wire which provides better resistance to abrasion and reaction by solvents and withstands higher temperatures. Asbestos covered wire is used for high operating temperatures and possesses good dielectric strength. Coverings made of glass fiber, known under different trade names like Fibreglas, etc., offer high temperature and moisture proof wire. Silicone or class "H" has many desirable characteristics.

Improvement in insulating varnishes represents great progress made in chemistry in the last few decades. Better varnishes made possible more economical and more efficient design of electrical equipment and contributed greatly to durable and lasting repairs. Varnish serves as a binder of conductors and saves them from ever present effects of electrical and mechanical vibration and friction. Varnish provides a protective coating against attack of moisture, oil, and abrasive, etc., and it assists in dissipation of heat from the unit. Varnish also increases the dielectric strength of conductor's insulation.

Factors which determine value of varnish are: depth of penetration, depth of drying, binding properties, insulating resistance, resistance to high temperatures, waterproofness, alkali resistance, acid resistance, physical toughness and flexibility.

ELECTRIC SHOP EQUIPMENT

Trucks and Automobiles
Electric Lift Trucks
Cranes
Hoist
Burn-out Oven
Tank for Chemical Stripping
Cleaning Tanks
Hydraulic Presses
Gas & Electric Baking Ovens
Degreasing Tank
Wire Strippers
Dispensing Wire Reels
Slot Cleaner Outfit
Induction Pinion Puller
Hydraulic Coil Press
Winches
Punch Presses
Commutator Soldering Pots
Modern High Speed Lathe
Shaper
Automatic Lathe
Taping Machines
Undercutting Machine
Portable Drill Press
Milling Machines
Bonding Machines
Tension Devices
Brazing & Soldering Devices
Hot Presses
Gas Torches
Stator & Armature Winding Stand
Strap Copper Bender
Vari-Speed Winders
Three Phase Winder
Armature Winding Head
Coil Spreader — Manual
Coil Spreader — Pneumatic
Air Operated Coil Holders
Arc Welder
Gas Welding Equipment
Brush Scaler
Coil Bender
Loop Field & Transformer Winder
Group Winder
Concentric Coil Winder
Insulation Cutter & Folder
Cutters
Power Shears & Saws
Lead Wire Stripper
Portable Gas Tank
Screw Driver — Measuring Tension
Dynamometer
Test Switchboard
Balancing Machine
Metallizing Sets
Portable Tester
Growler
Electric Baking Oven
Arbor Presses
Pulley Puller
Dipping Tank
Portable Mica Undercutters
Pneumatic Wrenches
Portable Tools

It is up to the repair engineer to determine which of these characteristics are paramount in the performance of equipment being repaired and to adopt the type of varnish that will fit these needs. There is no varnish all inclusive in characteristics.

Electric insulating varnishes commonly used in a repair shop are: Baking varnishes, air drying varnishes and finishing varnishes. Progress in composition and manufacturing of synthetic varnishes made it possible to combine mechanical strength with flexibility, to permit enough cushion to combat ever present vibration in electrical conductors.

Baking varnishes, which provide binding bond, are usually better applied if equipment is pre-heated. This process eliminates moisture from windings and expands conductors to allow better penetration of wet varnish into voids between them. Pre-heating results in a much better job. The impregnation cycle usually depends on equipment repaired and on conditions under which it is required to operate. Each varnish has a definite cycle, which must be adhered to in order to obtain good results. Quite often two varnishes of different characteristics are used to achieve needed results. Air drying varnishes offer exceptional corrosion protection which cannot be obtained otherwise. They also provide very smooth and glossy finish. Air drying varnish is used on quick emergency jobs.

All insulating materials used in electric shops are divided into three general classes known as: Class A, Class B, and Class H.

Class A consists of:

1.—Cotton, silk, paper and similar organic materials when either impregnated or immersed in a liquid dielectric.
2.—Molded and laminated materials with cellulose filler, phenolic resins and other resins of similar properties.
3.—Films and sheets of cellulose acetate and other cellulose derivatives of similar properties.
4.—Varnishes as applied to conductors.

Class B consists of: mica, asbestos, fiber glass, and similar inorganic materials in built-up form with organic binding substances.

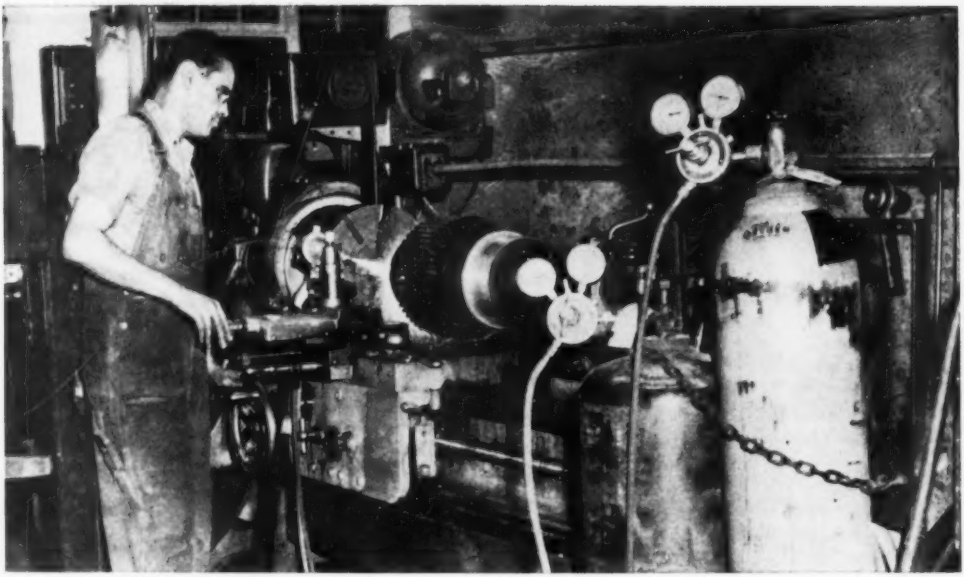
Class H is inorganic materials like: mica, porcelain, glass, and asbestos, bonded and impregnated with silicone resins.

All these types of insulation find definite use in electric motor work, depending on temperature at which electrical machinery is expected to operate. Higher temperatures accelerate the disintegration of insulation and thus lead to mechanical and electrical failure. The maximum permissible operating temperature of Class A is 105 degrees C. Its life decreases about 50% with each rise of 8 degrees in operating temperature. The maximum permissible operating temperature of Class B is 130 degrees C. Its life decreases about 50% with each 10% rise in operating temperature. The maximum permissible operating temperature of Class H insulation is 180 degrees C.

Tapes, cloth, papers, cords, sleeving, tubing, wedges, cements, and various adhesives are among shapes used in electric shops. They are made in all three classes listed above.

Silicones are the latest entrants into the group of electrical insulating materials. Silicones have properties similar to those of glass and mica and are made in various forms. Silicone resins, fluids and rubber-like compounds are among those adapted for use in electric shops. Silicone materials can be used like any other similar types of insulating materials, although special procedures are required.

Class H insulations are successfully applied on



METAL SPRAYING restores shafts to original diameter and dimensions for continued service.

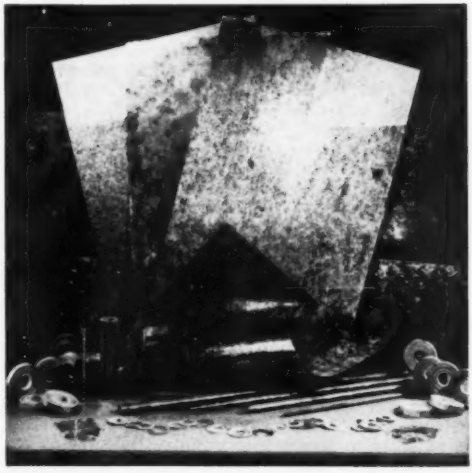
applications where extreme conditions of exposure to heat and moisture are encountered. In such instances, they prolong the life of insulation and equipment. The introduction of Silicone Class H insulations into industry opened new horizons. It makes smaller sized units possible and, sometimes, increases capacity of old re-built units. All insulating materials mentioned are special built to meet the demands of the electric industry.

Modern Shop Equipment & Techniques

Need for greater efficiency resulted in introduction of modern equipment in electric repair shops. Years ago equipment used in this business was all home made and rather crude. Today certain manufacturers build special equipment for the repair industry, and the quality of this factory-made machinery can hardly be duplicated in shop-made products.

Latest types of trucks, some re-built to meet special needs, bring the job into the shops. Cranes, trolley lift trucks, hoists—(electric and manual), are used in handling of material in shop. Parts, tools and materials are stored in a manner to facilitate handling of orders. High speed lathes, use of electric tools of all description and of any new devices that may be useful, all contribute to shop efficiency. List of electric shop equipment is shown on preceding page.

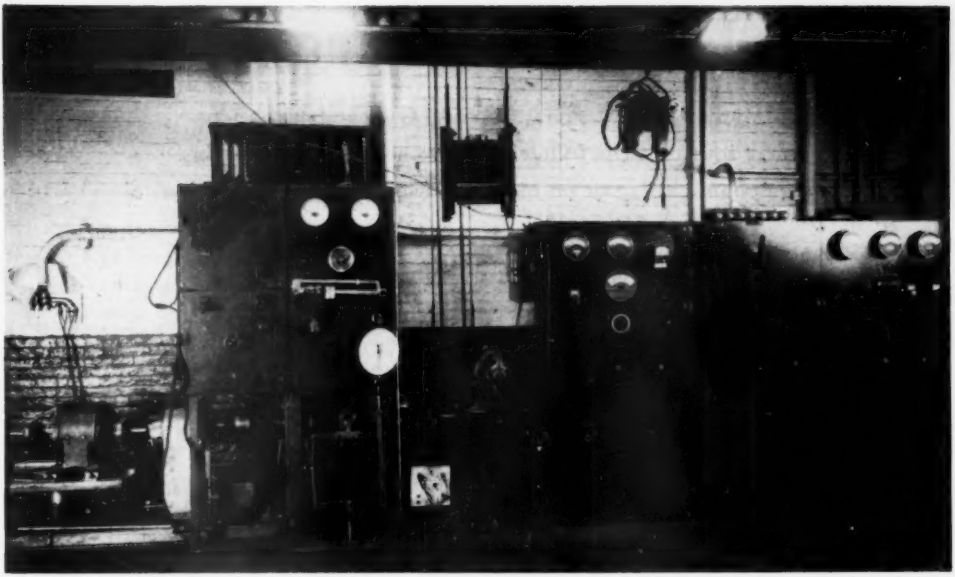
All steps involved in operation of a shop are carefully analyzed, and procedure established to perform each operation most efficiently. In a shop specializing on small motors, attempts are made to gather similar motors and specific operation on these in such manner that same jobs can be done at one time, thus practically working on mass production methods and with high speed. Prefabrication of parts, pre-cutting of materials, availability of needed materials within reach of each worker are important



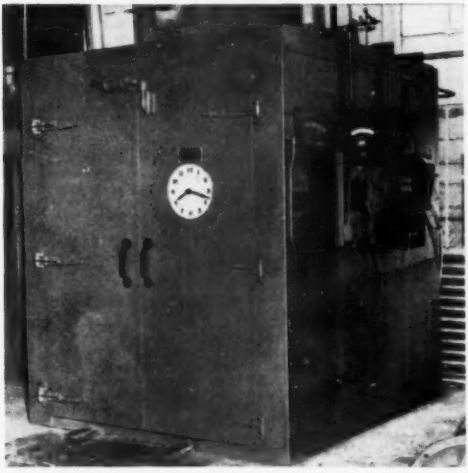
TYPICAL of insulating materials used in the modern shop are these mica sheets, tapes and forms.

in any shop; but, in fractional motor repair work, they are vital to successful operation. Recording and handling of each job in a systematic, careful manner is an important factor in efficient operation.

In stripping, gas burners, gas burning ovens, and chemical methods are used. Winches and hoists help lift old windings, and portable electric tools and air hammers are utilized in cutting ends of old stators. Roasting ovens must be equipped with some means of controlling temperature from reaching high and dangerous limit, at which permanent damage may



SHOP TESTING facilities of the Maintenance Co., New York, are typical of the extensive equipment required.



OVENS equipped with temperature controls and exhaust facilities are now standard equipment of modern motor shops.

be done to laminations, etc. Cleaning of stator after stripping is usually done by use of sand blasting, steam, and, more recently, of granulated corn cob and other abrasives and semi-abrasives which do "soft" job. Special vaults are provided for both paint spraying and blasting operation.

Repair or replacement of commutators is done in a manner designed to save time and eliminate waste motion. Successful attempts were made to introduce induction heating for commutator work. Special machines are used for undercutting of commutators.

In dipping, heavy and sturdy tanks should be employed, conveniently located.

Usually, upon arrival into the shop, complete examination is made to determine needed repairs. After completion, all jobs are subject to detailed and thorough tests, consisting of: mechanical inspection of all parts for tightness, proper fit, tolerances, etc.; check for freedom from short and open circuits, and grounds; testing under full load; insulation resistance test; dielectric test; and any special tests required by specification of job.

Engineering in Repair

There is a great amount of engineering effort going into repair work. It is the engineer's job to find ways and means to reduce expenses, increase efficiency, and consequently, increase margin of profit. A good engineer in electric repair work must have a thorough knowledge of electrical engineering and circuits, understand the principles of mechanical and structural engineering, and he must know materials, methods, and processes, and be capable of adapting all to the fluid and diversified nature of repair work with its endless variety of applications. The peculiar characteristics of service work require continuous readiness to meet new emergencies and solve new problems. Therefore, a man in charge of repairs must be equipped by training and experience to tackle a new type of work, analyze and diagnose the trouble, prescribe the remedy and apply corrective methods. Demands of new jobs must be met without interfering with repair and delivery of old jobs. The time limit and economic angles are always present. The service industry, in general, recognizes the need for more engineering in its work. More and more engineering talents are being solicited by the large progressive shops and service organizations. Good engineering today forms the foundation for industry's continued progress.

Useful Data for Wiring Design

From the 1951 National Electrical Code and other industry sources. The following tables are essential data for design and layout on modern wiring systems.

Allowable Current-Carrying Capacities of Insulated Conductors in Amperes

Not More Than Three Conductors in Raceway or Cable (Based on Room Temperature of 30 C. 86 F.)

Size AWG MCM	Rubber Type R Type RW Type RU Type RUW (14–2) Thermoplastic Type T Type TW	Rubber Type RH	Paper Thermoplastic Asbestos Type TA Var-Cam Type V Asbestos Var-Cam Type AVB	Asbestos Var-Cam Type AVA Type AVL	Impregnated Asbestos Type AI (14–8) Type AIA	Asbestos Type A (14–8) Type AA
14	15	15	25	30	30	30
12	20	20	30	35	40	40
10	30	30	40	45	50	55
8	40	45	50	60	65	70
6	55	65	70	80	85	95
4	70	85	90	105	115	120
3	80	100	105	120	130	145
2	95	115	120	135	145	165
1	110	130	140	160	170	190
0	125	150	155	190	200	225
00	145	175	185	215	230	250
000	165	200	210	245	265	285
0000	195	230	235	275	310	340
250	215	255	270	315	335	...
300	240	285	300	345	380	...
350	260	310	325	390	420	...
400	280	335	360	420	450	...
500	320	380	405	470	500	...
600	355	420	455	525	545	...
700	385	460	490	560	600	...
750	400	475	500	580	620	...
800	410	490	515	600	640	...
900	435	520	555	...	...	...
1,000	455	545	585	680	730	...
1,250	495	590	645	...	...	...
1,500	520	625	700	785	...	...
1,750	545	650	735	...	...	...
2,000	560	665	775	840	...	...

CORRECTION FACTOR FOR ROOM TEMPERATURES OVER 30 C. 86 F.

C.	F.						
40	104	.82	.88	.90	.94	.95	...
45	113	.71	.82	.85	.90	.92	...
50	122	.58	.75	.80	.87	.89	...
55	131	.41	.67	.74	.83	.86	...
60	140	...	.58	.67	.79	.83	.91
70	158	...	.35	.52	.71	.76	.87
75	167	...	...	.43	.66	.72	.86
80	176	...	...	.30	.61	.69	.84
90	194	...	...	...	.50	.61	.80
100	212	...	...	...	...	.51	.77
120	248	...	...	...	...	...	.69
140	284	...	...	...	...	...	.59

Notes for Table at Left

For explanation of Type Letters, and for recognized size of conductors for the various conductor insulations, see sections 3102 and 93101. For installation requirements, see section 3102, and the various articles of this code. For flexible cords see Tables 3 and 31.

1. ALUMINUM CONDUCTORS. For aluminum conductors, the allowable current-carrying capacities shall be taken as 84 percent of those given in the table for the respective sizes of copper conductor with the same kind of insulation.

2. BARE CONDUCTORS. If bare conductors are used with indulated conductors, their allowable current-carrying capacity shall be limited to that permitted for the insulated conductor with which they are used.

3. APPLICATION OF TABLE. For open wiring on insulators and for concealed knob-and-tube work, the allowable current-carrying capacities of Table 2 shall be used. For all other recognized wiring methods, the allowable current-carrying capacities of Table 1 shall be used, unless otherwise provided in this code.

4. MORE THAN THREE CONDUCTORS IN A RACEWAY. Table 1 gives the allowable current-carrying capacity for not more than three conductors in a raceway or cable. If the number of conductors in a raceway or cable is from 4 to 6, the allowable current-carrying capacity of each conductor shall be reduced to 80 percent of the values in Table 1. If the number of conductors in a raceway or cable is from 7 to 9, the allowable current-carrying capacity of each conductor shall be reduced to 70 percent of the values in Table 1.

Exceptions to the foregoing are specified in sections 3624, 3745, and 7265.

5. NEUTRAL CONDUCTOR. A neutral conductor which carries only the unbalanced current from other conductors, as in the case of normally balanced circuits of three or more conductors, shall not be counted in determining current-carrying capacities as provided for in the preceding paragraph.

In a 3-wire circuit consisting of two phase wires and the neutral of a 4-wire, 3-phase system, a common conductor carries approximately the same current as the other conductors and is not therefore considered as a neutral conductor.

6. ULTIMATE INSULATION TEMPERATURE. In no case shall conductors be associated together in such a way with respect to the kind of circuit, the wiring method employed, or the number of conductors, that the limiting temperature of the conductors will be exceeded.

7. USE OF CONDUCTORS WITH HIGHER OPERATING TEMPERATURES. If the room temperature is within 10 degrees C of the maximum allowable operating temperature of the insulation, it is desirable to use an insulation with a higher maximum allowable operating temperature; although insulation can be used in a room temperature approaching its maximum allowable operating temperature limit if the current is reduced in accordance with the table of correction factors for different room temperatures.

8. VOLTAGE DROP. The allowable current-carrying capacities in Tables 1 and 2 are based on temperature alone and do not take voltage drop into consideration.

9. OVERCURRENT PROTECTION. If the standard ratings and settings of overcurrent devices do not correspond with the ratings and settings allowed for conductors, the next higher standard rating and setting may be used, but not exceeding 150 percent of the allowable carrying capacity of the conductor.

10. DETERIORATION OF INSULATION. It should be noted that even the best grades of rubber insulation will deteriorate in time, so eventually will need to be replaced.

Number of Conductors in Conduit or Tubing

Rubber Covered, Types RF-32, RUF, R, RH, RW, RU, and RUW
Thermoplastic, Types TF, T and TW
One to Nine Conductors

Size AWG MCM	Number of Conductors in One Conduit or Tubing								
	1	2	3	4	5	6	7	8	9
18	½	½	½	½	½	½	½	¾	¾
16	½	½	½	½	½	½	¾	¾	¾
14	½	½	½	½	¾	¾	1	1	1
12	½	½	½	¾	¾	1	1	1	1¼
10	½	¾	¾	¾	1	1	1	1¼	1¼
8	½	¾	¾	1	1¼	1¼	1¼	1½	1½
6	½	1	1	1¼	1½	1½	2	2	2
4	½	1¼	*1¼	1½	1½	2	2	2	2½
3	¾	1¼	1¼	1½	2	2	2	2½	2½
2	¾	1¼	1¼	2	2	2	2½	2½	2½
1	¾	1½	1½	2	2½	2½	2½	3	3
0	1	1½	2	2	2½	2½	3	3	3
00	1	2	2	2½	2½	3	3	3	3½
000	1	2	2	2½	3	3	3	3½	3½
0000	1¼	2	2½	3	3	3	3½	3½	4
250	1¼	2½	2½	3	3	3½	4	4	4½
300	1¼	2½	2½	3	3½	4	4	4½	4½
350	1¼	3	3	3½	3½	4	4½	4½	5
400	1½	3	3	3½	4	4	4½	5	5
500	1½	3	3	3½	4	4½	5	5	6
600	2	3½	3½	4	4½	5	6	6	6
700	2	3½	3½	4½	5	5	6	6	...
750	2	3½	3½	4½	5	6	6	6	...
800	2	3½	4	4½	5	6	6	...	...
900	2	4	4	5	6	6	6	...	...
1000	2	4	4	5	6	6	...	...	...
1250	2½	4½	4½	6	6	...	...	...	...
1500	3	5	5	6	...	...	...	...	...
1750	3	5	6	6	...	...	...	...	...
2000	3	6	6	...	...	...	...	...	...

*Where a service run of conduit or electrical metallic tubing does not exceed 50 feet in length and does not contain more than the equivalent of two quarter bends from end to end two No. 4 insulated and one No. 4 bare conductors may be installed in 1-inch conduit or tubing.

Number of Conductors in Conduit or Tubing

More Than Nine Conductors
Rubber-Covered Types RF-32, RUF, R, RH, RU, RUW, RW
Thermoplastic Types TF, T, and TW

Size AWG	Maximum Number of Conductors in Conduit or Tubing						
	¾ Inch	1 Inch	1¼ Inch	1½ Inch	2 Inch	2½ Inch	3 Inch
18	12	20	35	49	80	115	176
16	10	17	30	41	68	97	150
14	..	10	18	25	40	59	90
12	..	..	15	21	35	50	77
10	..	..	13	17	29	41	64
8	..	..	..	10	17	25	38
6	..	..	..	..	..	15	23

Number of Conductors in Conduit or Tubing

Lead-Covered Types RL and RHL—600 V.

Size AWG MCM	Number of Conductors in One Conduit or Tubing											
	Single Conductor Cable				2-Conductor Cable				3-Conductor Cable			
	1	2	3	4	1	2	3	4	1	2	3	4
14	½	¾	¾	1	¾	1	1	1¼	¾	1¼	1½	1½
12	½	¾	¾	1	¾	1	1¼	1¼	1	1¼	1½	2
10	½	¾	1	1	¾	1¼	1¼	1½	1	1½	2	2
8	½	1	1¼	1½	1	1¼	1½	2	1	2	2	2½
6	¾	1¼	1½	1½	1¼	1½	2	2½	1¼	2½	3	3
4	¾	1¼	1½	1½	1¼	2	2½	2½	1½	3	3	3½
3	¾	1¼	1½	2	1¼	2	2½	3	1½	3	3	3½
2	1	1¼	1½	2	1¼	2	2½	3	1½	3	3½	4
1	1	1½	2	2	1½	2½	3	3½	2	3½	4	4½
0	1	2	2	2½	2	2½	3	3½	2	4	4½	5
00	1	2	2	2½	2	3	3½	4	2½	4	4½	5
000	1¼	2	2½	2½	2	3	3½	4	2½	4½	4½	6
0000	1¼	2½	2½	3	2½	3	3½	4½	3	5	6	6
250	1¼	2½	3	3	...	...	...	...	3	6	6	...
300	1½	3	3	3½	...	...	...	...	3½	6	6	...
350	1½	3	3	3½	...	...	...	...	3½	6	6	...
400	1½	3	3	3½	...	...	...	...	3½	6	6	...
500	1½	3	3½	4	...	...	...	...	4	6	...	...
600	2	3½	4	4½	...	...	...	...	...	...	...	...
700	2	4	4	5	...	...	...	...	...	...	...	...
750	2	4	4	5	...	...	...	...	...	...	...	...
800	2	4	4½	5	...	...	...	...	...	...	...	...
900	2½	4	4½	5	...	...	...	...	...	...	...	...
1000	2½	4½	4½	6	...	...	...	...	...	...	...	...
1250	3	5	5	6	...	...	...	...	...	...	...	...
1500	3	5	6	6	...	...	...	...	...	...	...	...
1750	...	6	6	...	...	...	...	...	...	...	...	...
2000	3½	6	6	...	...	...	...	...	...	...	...	...

Combination of Conductors

For groups or combinations of conductors the conduit or tubing should be of such size that the sum of the cross-sectional areas of the individual conductors will not be more than the percentage of the interior cross-sectional area of the conduit or tubing shown in the following table:

Per Cent Area of Conduit or Tubing

	Number of Conductors				
	1	2	3	4	Over 4
Conductors (not lead covered)	53	31	43	40	40
Lead-covered conductors	55	30	40	38	35
For rewiring existing raceways for increased load where it is impracticable to increase the size of the raceway due to structural conditions	60	40	50	50	50

Properties of Copper Conductors

Size AWG	Area Cir. Mils	Concentric Lay Stranded Conductors: No. Wires	Concentric Lay Stranded Conductors: Diam. Each Wire Inches	Bare Conductors: Diam. Inches	Bare Conductors: *Area Sq. Inches	D. C. Resistance Ohms/M Ft. At 25 C. 77 F.: Bare Cond.	D. C. Resistance Ohms/M Ft. At 25 C. 77 F.: Tin'd. Cond.
18	1624	Solid	.0403	.0403	.0013	6.510	6.77
16	2583	Solid	.0508	.0508	.0020	4.094	4.25
14	4107	Solid	.0641	.0641	.0032	2.575	2.68
12	6530	Solid	.0808	.0808	.0051	1.619	1.69
10	10380	Solid	.1019	.1019	.0081	1.018	1.06
8	16510	Solid	.1285	.1285	.0130	.641	.660
6	26250	7	.0612	.184	.027	.410	.426
4	41740	7	.0772	.232	.042	.259	.269
3	52640	7	.0867	.260	.053	.205	.213
2	66370	7	.0974	.292	.067	.162	.169
1	83690	19	.0664	.332	.087	.129	.134
0	105500	19	.0745	.373	.109	.102	.106
00	133100	19	.0837	.418	.137	.0811	.0844
000	167800	19	.0940	.470	.173	.0642	.0668
0000	211600	19	.1055	.528	.219	.0509	.0524
	250000	37	.0822	.575	.260	.0431	.0444
	300000	37	.0900	.630	.312	.0360	.0371
	350000	37	.0973	.681	.364	.0308	.0318
	400000	37	.1040	.728	.416	.0270	.0278
	500000	37	.1162	.814	.520	.0216	.0225
	600000	61	.0992	.893	.626	.0180	.0185
	700000	61	.1071	.964	.730	.0154	.0159
	750000	61	.1109	.998	.782	.0144	.0148
	800000	61	.1145	1.031	.835	.0135	.0139
	900000	61	.1215	1.093	.938	.0120	.0124
	1000000	61	.1280	1.152	1.042	.0108	.0111
	1250000	91	.1172	1.289	1.305	.00864	.00890
	1500000	91	.1284	1.412	1.566	.00719	.00740
	1750000	127	.1174	1.526	1.829	.00617	.00636
	2000000	127	.1255	1.631	2.089	.00539	.00555

* Area given is that of a circle having a diameter equal to the overall diameter of a stranded conductor.

The values given in the table are those given in Circular 31 of the National Bureau of Standards except that those shown in the last column are those given in Specification B33 of the American Society for Testing Materials.

The resistance values given in the last two columns are applicable only to direct current. When conductors larger than No. 4/0 are used with alternating current the following multiplying factors should be used to compensate for skin effect.

Conduit Sizes

Cables above 600 volts, also control cables
Cables of Equal Diameter

Number of Cables in Conduit	Nominal Size of Conduit*											
	½"	¾"	1"	1¼"	1½"	2"	2½"	3"	3½"	4"	4½"	5"
	Maximum Cable Diameter in Inches											
1	.46	.61	.78	1.03	1.20	1.54	1.84	2.29	2.67	3.01	3.37	3.77
2	.25	.33	.42	.55	.64	.82	.98	1.22	1.42	1.61	1.80	2.02
3	.23	.31	.39	.52	.60	.77	.92	1.15	1.33	1.50	1.68	1.89
4	.20	.26	.33	.44	.51	.65	.78	.97	1.13	1.27	1.42	1.59
5		.22	.28	.37	.43	.55	.66	.82	.95	1.08	1.21	1.35
6		.20	.26	.34	.40	.51	.61	.76	.89	1.00	1.12	1.25
7		.19	.24	.32	.37	.47	.57	.70	.82	.93	1.04	1.16
8			.22	.30	.35	.44	.53	.66	.76	.86	.97	1.08
9			.21	.28	.33	.42	.50	.62	.72	.81	.91	1.02

EXAMPLE: A 1½" conduit will accommodate 3 cables with diam. .52" to .60".

*Conduit sizes are based on a straight run of 200', 100' with 2–90° bends or 50' with 3–90° bends. For installations exceeding these limiting conditions use one or two conduit sizes larger.

Wire Sizes for Motor Circuits

For Amperes at Full Load

Motor Rating Amperes	Rubber Insulation	Motor Rating Amperes	Rubber Insulation	Motor Rating Amperes	Rubber Insulation
1 – 12	No. 14	78 & 80	No. 1	290	500
13 & 14	No. 12	82 – 88	No. 1/0	300	500
15 & 16	No. 12	90 – 96	No. 1/0	320	500
17 – 20	No. 10	98 & 100	No. 1/0	340 & 360	600
22 & 24	No. 8	105 – 120	No. 2/0	380	700
26 & 28	No. 8	125 – 140	No. 3/0	400	700
30 & 32	No. 6	145 – 160	No. 200	420	800
34 – 40	No. 6	165	No. 4/0	440	800
42 & 44	No. 5	170 – 180	4/0	460 & 480	900
46 & 48	No. 4	185 & 190	250 M.C.M.	500 & 520	1000
50 & 52	No. 4	195 & 200	250	540	1100
54 & 56	No. 4	210	300	560	1200
58 – 64	No. 3	220	300	580	1200
66 & 68	No. 2	230 & 240	350	600	1300
70 & 72	No. 2	250 & 260	400	625	1400
74 & 76	No. 1	270 & 280	500	...	....

Dimensions of Rubber-Covered and Thermoplastic-Covered Conductors

Size AWG MCM	Types RF-32, R, RH, RW		Types TF, T, TW, RU**, RUF, RUW	
	Approx. Diam. Inches	Approx. Area Sq. Ins.	Approx. Diam. Inches	Approx. Area Sq. Ins.
18	.146	.0167	.106	.0088
16	.158	.0196	.118	.0109
14	3/32 in. .171	.0230	.131	.0135
14	1/8 in. .204	.0327		
12	3/32 in. .188	.0278	.148	.0172
12	1/8 in. .221	.0384		
10	.242	.0460	.168	.0224
8	.311	.0760	.228	0408
6	.397	.1238	.323	.0819
4	.452	.1605	.372	.1087
3	.481	.1817	.401	.1263
2	.513	.2067	.433	.1473
1	.588	.2715	.508	.2027
0	.629	.3107	.549	.2367
00	.675	.3578	.595	.2781
000	.727	.4151	.647	.3288
0000	.785	.4840	.705	.3904
250	.868	.5917	.788	.4877
300	.933	.6837	.843	.5581
350	.985	.7620	.895	.6291
400	1.032	.8365	.942	.6969
500	1.119	.9834	1.029	.8316
600	1.233	1.1940	1.143	1.0261
700	1.304	1.3355	1.214	1 1575
750	1.339	1.4082	1.249	1.2252
800	1.372	1.4784	1.282	1.2908
900	1.435	1.6173	1.345	1.4208
1000	1.494	1.7531	1.404	1.5482
1250	1.676	2.2062	1.577	1.9532
1500	1.801	2.5475	1.702	2.2748
1750	1.916	2.8895	1.817	2.5930
2000	2.021	3.2079	1.922	2.9013

**No. 14 to No. 2.
No. 18 to No. 8, solid; No. 6 and larger, stranded.

Dimensions of Conduit or Tubing

Size	Internal Diameter Inches	Area Square Inches	Size	Internal Diameter Inches	Area Square Inches
½	.622	.30	3	3.068	7.38
¾	.824	.53	3½	3.548	9.90
1	1.049	.86	4	4.026	12.72
1¼	1.380	1.50	4½	4.506	15.95
1½	1.610	2.04	5	5.047	20.00
2	2.067	3.36	6	6.065	28.89
2½	2.469	4.79			

Dimensions of Asbestos-Varnished-Cambric

Insulated Conductors
Types AVA, AVB, and AVL

Size AWG MCM	Type AVA		Type AVB		Type AVL	
	Approx. Diam. Inches	Approx. Area Sq. In.	Approx. Diam. Inches	Approx. Area Sq. In.	Approx Diam. Inches	Approx. Area Sq. In.
14	.245	.047	.205	.033	.320	.080
12	.265	.055	.225	.040	.340	.091
10	.285	.064	.245	.047	.360	.102
8	.310	.075	.270	.057	.390	.119
6	.395	.122	.345	.094	.430	.145
4	.445	.155	.395	.123	.480	.181
2	.505	.200	.460	.166	.570	.255
1	.585	.268	.540	.229	.620	.300
0	.625	.307	.580	.264	.660	.341
00	.670	.353	.625	.307	.705	.390
000	.720	.406	.675	.358	.755	.447
0000	.780	.478	.735	.425	.815	.521
250	.885	.616	.855	.572	.955	.715
300	.940	.692	.910	.649	1.010	.800
350	.995	.778	.965	.731	1.060	.885
400	1.040	.850	1.010	.800	1.105	.960
500	1.125	.995	1.095	.945	1.190	1.118
550	1.165	1.065	1.135	1.01	1.265	1.26
600	1.205	1.140	1.175	1.09	1.305	1.34
650	1.240	1.21	1.210	1.15	1.340	1.41
700	1.275	1.28	1.245	1.22	1.375	1.49
750	1.310	1.35	1.280	1.29	1.410	1.57
800	1.345	1.42	1.315	1.36	1.440	1.63
850	1.375	1.49	1.345	1.43	1.470	1.70
900	1.405	1.55	1.375	1.49	1.505	1.78
950	1.435	1.62	1.405	1.55	1.535	1.85
1,000	1.465	1.69	1.435	1.62	1.565	1.93

Note: No. 14 to No. 8, solid, No. 6 and larger, stranded; except AVL where all sizes are stranded.

Dimensions of Lead-Covered Conductors

Types RL, RHL, and RUL

Size AWG MCM	Single Conductor		Two Conductor		Three Conductor	
	Diam. Inches	Area Sq. In.	Diam. Inches	Area Sq. In.	Diam. Inches	Area Sq. In.
14	.28	.062	.28 x .47	.115	.59	.273
12	.29	.066	.31 x .54	.146	.62	.301
10	.35	.096	.35 x .59	.180	.68	.363
8	.41	.132	.41 x .71	.255	.82	.528
6	.49	.188	.49 x .86	.369	.97	.738
4	.55	.237	.54 x .96	.457	1.08	.916
2	.60	.283	.61 x 1.08	.578	1.21	1.146
1	.67	.352	.70 x 1.23	.756	1.38	1.49
0	.71	.396	.74 x 1.32	.859	1.47	1.70
00	.76	.454	.79 x 1.41	.980	1.57	1.94
000	.81	.515	.84 x 1.52	1.123	1.69	2.24
0000	.87	.593	.90 x 1.64	1.302	1.85	2.68
250	.98	.754	.....	.....	2.02	3.20
300	1.04	.85	.....	.....	2.15	3.62
350	1.10	.95	.....	.....	2.26	4.02
400	1.14	1.02	.....	.....	2.40	4.52
500	1.23	1.18	.....	.....	2.59	5.28

Note—No. 14 to No. 8, solid conductors: No. 6 and larger, stranded conductors. Data for 2/64-inch insulation not yet compiled.

Full-Load Current*

Direct-Current Motors

HP	115V	230V	550V
½	4.6	2.3	
¾	6.6	3.3	1.4
1	8.6	4.3	1.8
1½	12.6	6.3	2.6
2	16.4	8.2	3.4
3	24.	12.	5.0
5	40.	20.	8.3
7½	58.	29.	12.0
10	76.	38.	16.0
15	112.	56.	23.0
20	148.	74.	31.
25	184.	92.	38.
30	220.	110.	46.
40	292.	146.	61.
50	360.	180.	75.
60	430.	215.	90.
75	536.	268.	111.
100		355.	148.
125		443.	184.
150		534.	220.
200		712.	295.

*These values for full-load current are average for all speeds.

Full-Load Current*

Single-Phase A.C. Motors

HP	115V	230V	440V
⅙	3.2	1.6	
¼	4.6	2.3	
½	7.4	3.7	
¾	10.2	5.1	
1	13.	6.5	
1½	18.4	9.2	
2	24.	12.	
3	34.	17.	
5	56.	28.	
7½	80.	40.	21.
10	100.	50.	26.

For full-load currents of 208 and 200-volt motors, increase corresponding 230-volt motor full-load current by 10 and 15 per cent, respectively.

*These values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, in which case the nameplate current, rating should be used.

Full-Load Current*

Two-Phase A.C. Motors (4-wire)

	Induction Type Squirrel-Cage and Wound Rotor Amperes					Synchronous Type †Unity Power Factor Amperes			
HP	110V	220V	440V	550V	2300V	220V	440V	550V	2300V
½	4	2	1	.8					
¾	4.8	2.4	1.2	1.0					
1	6.4	3.2	1.6	1.3					
1½	8.8	4.4	2.2	1.8					
2	11.2	5.6	2.8	2.2					
3		8	4	3.2					
5		13	7	6					
7½		19	9	8					
10		24	12	10					
15		34	17	14					
20		45	23	18					
25		55	28	22	6	47	24	19	4.7
30		67	34	27	7.5	56	29	23	5.7
40		88	44	35	9	75	37	31	7
50		108	54	43	11	94	47	38	9
60		129	65	52	13	111	56	44	11
75		158	79	63	16	140	70	57	13
100		212	106	85	21	182	93	74	17
125		268	134	108	26	228	114	93	22
150		311	155	124	31		137	110	26
200		415	208	166	41		182	145	35

*These values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, in which case the nameplate current rating should be used. Current in common conductor of 2-phase, 3-wire system will be 1.41 times value given.

†For 90 and 80 per cent P. F. the above figures should be multiplied by 1.1 and 1.25 respectively.

Full-Load Current*

Three-Phase A.C. Motors

	Induction Type Squirrel-Cage and Wound Rotor Amperes					Synchronous Type †Unity Power Factor Amperes			
HP	110V	220V	440V	550V	2300V	220V	440V	550V	2300V
½	4	2	1	.8					
¾	5.6	2.8	1.4	1.1					
1	7	3.5	1.8	1.4					
1½	10	5	2.5	2.0					
2	13	6.5	3.3	2.6					
3		9	4.5	4					
5		15	7.5	6					
7½		22	11	9					
10		27	14	11					
15		40	20	16					
20		52	26	21					
25		64	32	26	7	54	27	22	5.4
30		78	39	31	8.5	65	33	26	6.5
40		104	52	41	10.5	86	43	35	8
50		125	63	50	13	108	54	44	10
60		150	75	60	16	128	64	51	12
75		185	93	74	19	161	81	65	15
100		246	123	98	25	211	106	85	20
125		310	155	124	31	264	132	106	25
150		360	180	144	37		158	127	30
200		480	240	192	48		210	168	40

For full-load currents of 208 and 200 volt motors, increase the corresponding 220-volt motor full-load current by 6 and 10 per cent respectively.

*These values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, in which case the nameplate current rating should be used.

†For 90 and 80 percent P. F. the above figures should be multiplied by 1.1 and 1.25 respectively.

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(24) Remote-Control Wiring Local Advertising Portfolio #16-321—contains complete kit of news releases, radio spot commercials, radio transcription records, and newspaper mats.

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(29) Drive-in Theater Cable Bulletin #19-90—describes specific Versatol*, Geoprene, and Flamenol cables developed for drive-in theater wiring circuits.

(30) Bar Hanger Folder #18-47—describes S-type bar hanger with new heavy-duty stud, for residential wiring.

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Typical damage to generator windings

It naturally follows that a regular program of checking the condition of electrical insulation pays off. Much can be saved in prevention of motor damage, wasted current, loss of production and *danger* to life and property.

For more than a half century the Megger Insulation Tester has been a highly effective means for testing any type of electrical equipment, whether a-c or d-c and irrespective of the voltage rating of the apparatus. It is direct-reading, easy to use and has its own source of power. It permits non-destructive tests which disclose incipient insulation weaknesses, rather than merely signaling insulation breakdown that has already occurred.

A series of periodic tests recorded on charts supplied with each Megger set assures you that the insulation of a machine is holding up . . . or warns you that insulation is becoming weaker and conditions should be investigated.

Most Trouble is Caused by Dirt or Moisture

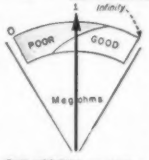
It is more economical to blow out dust, dry out coil windings, eliminate oil conditions, or even replace a motor or generator on off-hours *at the convenience* of the production and maintenance departments—than to have trouble strike unexpectedly and production interrupted indefinitely.

The story of electrical insulation resistance is told in our easy-to-read booklet entitled "For Practical Men." Most maintenance men, who have seen it, have requested extra copies for their associates. *Yours* will be mailed free of charge by simply writing for Bulletin 21P8-ECM.

GETTING THE MOST FROM INSULATION RESISTANCE MEASUREMENTS . . .

Interpreting Results When Time and Test Voltage are Changed

Electrical men agree that the accepted method of determining whether insulation is healthy is by measuring its resistance. Megger Insulation Testers have long been the popular choice of men charged with the responsibility of electrical maintenance. These men recognize the importance of the proper analysis of the readings they obtain with their Megger instruments. The best thinking of men who know is available in Biddle literature on the subject. For our latest publication on electrical insulation resistance, "For Practical Men," just write to us at the address above and we will mail it at no obligation. Many who have already read this helpful booklet are requesting additional copies for their departments. Ask for Bulletin 21P8-ECM.



ONE MEGOHM per 1000 v is still a good practical guide

THERE'S ECONOMY IN THE FLEXIBILITY OF THIS INSTRUMENT . . .

Dual-Operated Meg Type Megger® Insulation Tester

Serves for field tests where no current is available or for repetitive or time tests by plugging into 115 v. 60 cycles.

Operate by hand or plug in the rectifier—it's always ready for service—either way.

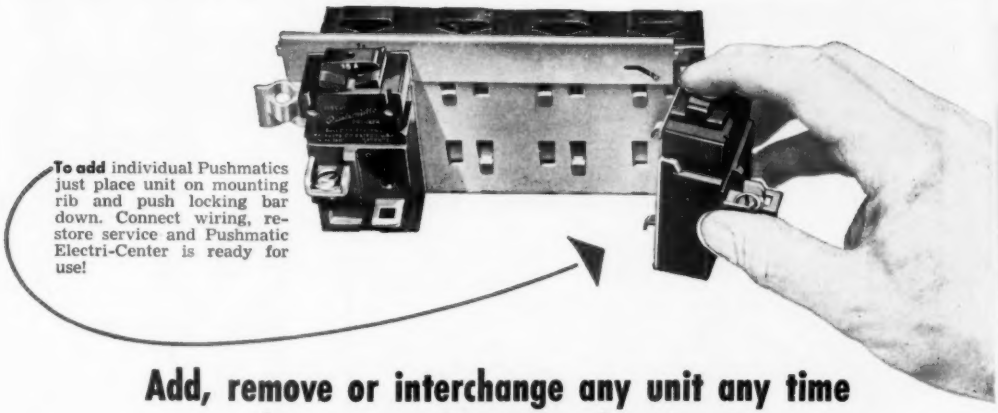
The rectifier offers advantages for such applications as:

1. Production testing of all types of electrical equipment and components.
2. Testing multi-conductor communication cables, as in telephone plants.
3. Testing multi-conductor control circuits in power plants.
4. Acceptance tests, such as from load centers, in lighting and power installations.
5. Testing multi-conductor control and power circuits at central locations in railway signal installations.
6. Testing generators, cables and other equipment by the time-resistance method, where the dielectric absorption or leakage current of the insulation under test is high enough to bring the resistance measurement within the range of these models.
7. Experimental and laboratory use.

Write for Bulletin 21-46-ECM.

We are constantly publishing new technical bulletins on Biddle Instruments. A complete list of our latest bulletins will be mailed you on request, so that you may check it to bring your files up to date. Request list ECM.

Meet specific panelboard needs faster with interchangeable *Pushmatics*®



To add individual Pushmatics just place unit on mounting rib and push locking bar down. Connect wiring, restore service and Pushmatic Electri-Center is ready for use!

Add, remove or interchange any unit any time for any combination of ratings!

NEVER before has a panelboard offered the flexibility of BullDog Pushmatic Electri-Centers!

Pushmatics are the same size, regardless of rating or type, and are completely interchangeable. Any Pushmatic can be installed at any point on the mounting rib. Pushmatics can be added to the Electri-Center faster, more economically and with less confusion.

Exclusive push-button switching, too!

PUSH . . . it's on! PUSH . . . it's off! PUSH . . . it's on again if circuit is broken by short or overload. Pushmatic offers the simplest switching available anywhere. No complicated resetting to fuss with . . . no fuses to replace.

And you can meet any load condition with these Pushmatics: Standard Thermal MAGNETIC and Thermal ULTRA-MAGNETIC, the latter available with or without BullDog's exclusive AMBIENT COMPENSATING FEATURES. Ratings of 15, 20, 30, 40 and 50 amperes, 1 pole, 120 V., or 2 poles, 120-240 V., A.C.

Now investigate Pushmatic Electri-Centers . . . the finest panelboards on the market.

Handsome BullDog Pushmatic Electri-Centers are available from 2 to 42 circuits. Pictured: 8-circuit Service Equipment Type. Plenty of wiring room even in smallest Electri-Centers for easier installation.

BULLDOG ELECTRIC PRODUCTS COMPANY
DETROIT 32, MICHIGAN • FIELD OFFICES IN ALL PRINCIPAL CITIES
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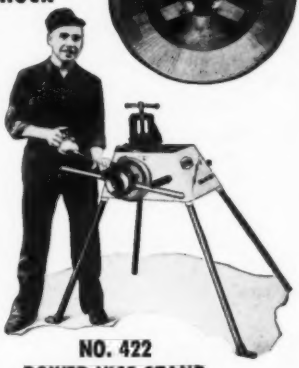

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POWER VISE STAND

Buy the pipe machine that pays for itself in the LEAST time—buy the Oster No. 422 POWER VISE STAND. Its EXCLUSIVE "Auto-Grip" Front Chuck *automatically* grips any kind of pipe. This machine is now the FASTEST of its kind for chucking, threading, cutting and reaming pipe by power-using your own hand tools. Range ⅛" to 2" pipe up to 8" with drive shaft. *WRITE FOR CATALOG NO. 422.*

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FIRST WITH THE BEST IN THREADING MACHINES SINCE 1893

For Important *Rewind* Jobs—

NATVAR Slot Cell Insulation

Rewinding a 700 H.P., 900 RPM, 3 phase, 60 cycle, 6900 v., type ATI, G-E Synchronous Motor calls for painstaking skill, good shop equipment and good materials. In rewinding this big boy, Braunlich-Roessle used Natvar Slot Cell Insulation, Natvar Varnished Cambric Tape and Natvar Varnished Fiberglas Sleeving.

The Braunlich-Roessle Co., Pittsburgh, Pa., serves a large industrial area, and their motor repair shop has enjoyed a fine reputation for competent work for 34 years. To Mr. Braunlich, a past president of National Industrial Service Association, all rewind jobs are *important*, whether large or small. They use Natvar Slot Cell Insulation, and other Natvar insulations, because they know they can depend on their uniformity and satisfactory performance in the completed job.

Natvar Slot Insulation is composed of 100% rag paper stock to which a layer of Natvar V.C. is firmly bonded. This combination of the high dielectric strength and moisture resistance of Natvar V.C. with the toughness and abrasion resistance of 100% rag paper makes a rugged slot insulation which withstands pounding and chafing without impairment of electrical properties.

Prompt deliveries can be made from your wholesaler's stock or direct from our own.

Natvar

Natvar Products

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- Varnished canvas
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- Varnished Fiberglas cloth
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- Varnished papers
- Slot insulation
- Varnished tubings and sleevings
- Varnished identification markers
- Lacquered tubings and sleevings
- Extruded vinyl tubing and tape
- Extruded vinyl identification markers

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NATVAR: RAHWAY, N. J.

205 RANDOLPH AVENUE ★ WOODBRIDGE, NEW JERSEY

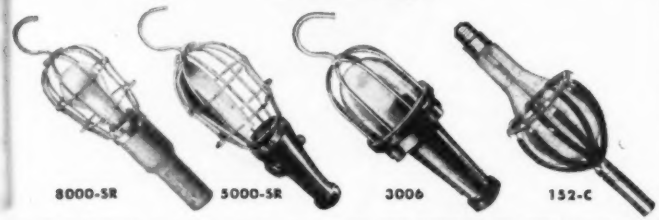
Unsurpassed for Quality

McGILL® 5025 SLR GUARD

with lens, reflector, convenience outlet

Portable Lamp Guards under the trade mark McGILL have been accepted with assurance of superior design, materials and workmanship for over 40 years. A reliable guarantee of greater dependability and longer life in industrial service.

The new No. 5025-SLR beams light to inaccessible places through an end lens. Has 15 Amp. 125 volt power tool outlet in phenolic plastic handle. Levolier switch, reflector, grease and heat resisting cord. Underwriters' Laboratories Inspected.



8000-SR 5000-SR 3006 152-C

No. 8000 SR Guard is a fine general service guard, identical in construction to the 7000 rubber handle Series, except equipped with stout polished birch wood handle. Cages are of extra heavy steel wires, electrically welded and heavily zinc plated.

No. 5000 SR Guard—features the new approved, phenolic plastic handle with convenience outlet and Levolier switch. Closed end cage for 100 watt bulb.

No. 3006 VAPORPROOF GUARD — Designed to provide absolute protection wherever portable lighting must be watertight, dust-tight and moisture proof. A heat and impact resisting glass globe screws into a rubber gasket. Plastic handle sealed with a diaphragm washer.

No. 152-C LAMP CHANGER—for 100 watt bulb. Other types of changer heads are available. New light-weight steel pole is furnished in 5½ ft. sections, insulated, extends to reach a recommended maximum of 30 feet.

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COMMSTONE HOLDERS

Hold Commstones rigid and true for concentric re-surfacing of commutators and slip rings while running at normal speeds in their own bearings. Interchangeable boxes 1", 2" and 3" wide handle grinding jobs up to 4¼" wide.

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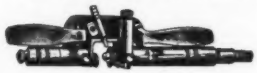
MICA UNDERCUTTERS FOR SLOTTING COMMUTATORS



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Mark motors and other equipment with service data. Three other styles available.

Write for 64-page Catalog describing these and many other products for Industrial Maintenance, Safety and Production.

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1309 Hird Ave. Cleveland 7, Ohio

Insulating News

News of G-E electrical insulating developments that can be important to your business.

G-E GLYPTAL* VARNISHED CAMBRIC PICKED FOR TOP-QUALITY REPAIRS

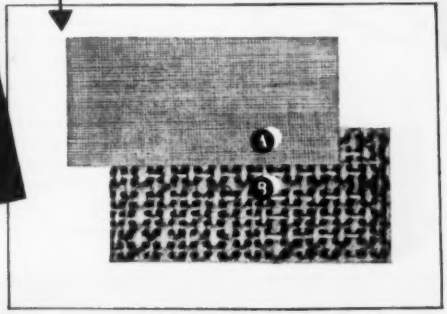
Particularly now—when defense production must be kept at a peak—G-E Glyptal varnished cambric insulation is specified for important rewind jobs to assure long, continuous operation of vital electrical equipment.

This Class A material is more than five times as heat resistant as conventional cloth. It is also highly resistant to oil and mechanical abrasion. Because of this, Glyptal-cloth-insulated equipment is less likely to fail under overloads or when the ambient climbs high.

Such outstanding performance is the result of treating high-quality cambric cloth with famous G-E-developed Glyptal varnish. Only cloth of low sizing content is used, to permit maximum varnish impregnation and correspondingly high insulating value. For the Class A insulating cloth you can depend on, specify G-E 1780 or G-E 1782 Glyptal Varnished Cambric. Write for specifications, prices, etc. on this or any of the top-quality G-E insulating materials: Section AB-3, Chemical Division, General Electric Company, Pittsfield, Massachusetts.

* Reg. U. S. Pat. Off.

Laboratory chemist tests General Electric varnishes for viscosity—one step in continuous G-E quality control.



1. shows finished G-E varnished insulating cloth.
2. shows magnified section of low-sizing-content base cloth used by G.E., which permits maximum varnish impregnation for better insulating qualities.

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Sealing and Filling Compounds
Mica Insulation · Varnished Cloths and Tapes

Also—look to General Electric for a complete line of laminated sheets, tubes and rods, and molded laminates (with cloth, paper, glass fabric or special bases) for a wide variety of insulation and other industrial uses.

"No equipment is better than its insulation"

You can put your confidence in

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NEW BOOKLET OFFERS TIPS ON TESTING . . . write for FREE copy

G. E.'s new "Buyer's Guide to Test Instruments" helps you select the right instruments for different electrical testing and maintenance jobs. For instance, the "Guide" tells you what instruments to use to:

- *prevent motor burnouts*
- *improve power factor*
- *troubleshoot*
- *locate grounded coils*
- *predict motor rotation*
- *balance loads*
- *record voltages*
- *check power losses*
- *improve efficiency, etc.*

AK-1 Hook-on volt-ammeter

AK-2 Hook-on wattmeter

AK-3 Hook-on Power-factor Meter

CF-1 Recorder

G-E portable testing instruments are sturdy, accurate, very easy to use. For example, the hook-on instruments permit voltage, current, or power measurements without interrupting service. Start now to make your testing jobs simpler. Fill out the coupon and send it in for your free copy of the "Buyer's Guide", General Electric Company, Schenectady 5, N. Y.

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Its Application to Shipboard Electrical Equipment

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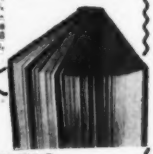

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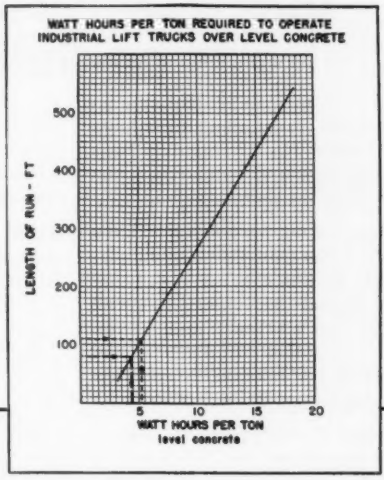

This graph plus easily worked formulas enable you to compute required watt-hours.

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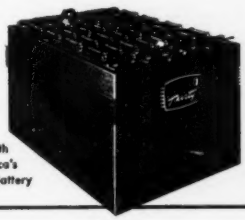
Battery selection should be made only after careful analysis of the route truck will travel and the load it will handle. Knowing weight of truck empty, amount of average load, average length of run and length and percent of grades encountered, simple, easy formulas enable you to calculate the battery capacity needed for 1) level run loaded; 2) going up grade; 3) return trip empty; 4) lifting; 5) tilting. The sum of these five computations gives total watt hours necessary for trip. Multiplying by trips a day gives total daily watt hours required. Dividing this total by battery voltage required gives minimum battery capacity for the job.



Gould "Thirty" with "Z" plates—America's Finest Industrial Truck Battery

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GOULD-NATIONAL BATTERIES, INC., TRENTON 7, NEW JERSEY

Always Use Gould-National Automobile and Truck Batteries

One-tape method cuts costs on Gulf Coast

Bellaire, Texas, contractor finds "SCOTCH" No. 33 Electrical Tape does the job of two conventional tapes, gives compact splices.

Figure it out for yourself! That's what this Gulf Coast contractor did. Add up the cost of the conventional insulating tapes and the time it takes to apply them. Compare that with the total cost per slice of "SCOTCH" No. 33 Electrical Tape. A lot less isn't it?

And this tough, plastic tape gives better results, too. It's stretchy and super-thin with a dielectric strength of 10,000 volts. That means more compact splices—no crowded junction boxes, fittings, fixture openings.

Perfect for indoor *or* outdoor wiring, because the vinyl plastic is unaffected by sunlight, resists weathering, stays water-resistant.

Get the new "Job Size" rolls from your wholesaler. They're just what you've been looking for —¾ in. x 20 ft.—economical, yet large enough to handle many jobs. Ask for "SCOTCH" No. 33 Electrical Tape today!

NEW "JOB SIZE" ROLLS are packed 12 in a screw-top container to keep out dust and dirt, prevent bruising of tape in tool boxes. Rolls are ¾ in. x 20 ft. "Economy Size" 66-ft. rolls also available.

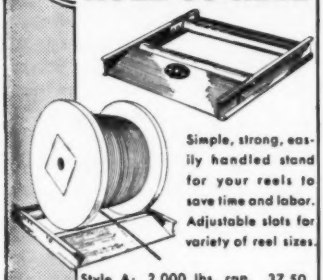
SCOTCH BRAND Electrical Tape No. 33

The term "Scotch" and the plaid design are registered trade-marks for the more than 100 Pressure-sensitive adhesive tapes made in U.S.A. by **MINNESOTA MINING & MFG. CO.**, St. Paul 6, Minn.—also makers of "Scotch" Sound Recording Tape, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-Slip Surfacing, "3M" Abrasives, "3M" Adhesives. General Export: Minnesota Mining & Mfg. Co., International Division, 270 Park Avenue, New York 17, N. Y. In Canada: Canadian Minn. Mining & Mfg. Co., Ltd., London, Canada.

Time to Discard OLD-FASHIONED WAYS

Jacks . . props . . shores . . horses . . why fool with these obsolete methods of handling reels? DO IT THE MODERN, EFFICIENT WAY! Reel or unreel wire, cable, rope with

ROLL-A-REEL



Simple, strong, easily handled stand for your reels to save time and labor. Adjustable slots for variety of reel sizes.

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gives lowest cost per foot of concrete drilled because it:

- Drills at 2 to 6 inches per minute
- Drills reinforcing bars and beams in concrete
- Drills up to 30 feet of concrete without resharpening
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- Uses ordinary electric drill

Quiet cutting action gives minimum disturbance of surrounding activities.

Tilden drill bits are available in standard sizes of from ¼" to 4" diameters. Quotations on larger sizes on request.

Write today for catalog with complete details on these revolutionary concrete drill bits.

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NEW CLASS H* MOTORS PROTECTED BY DOW CORNING SILICONES

. . . the insulation that has already saved industry millions of maintenance dollars plus the hourly output of hundreds of thousands of men!

This most timely announcement caps the test program we started 8 years ago when silicone resins were introduced by Dow Corning Corporation. First we proved by accelerated life testing that silicone insulated motors had a good 10 to 1 advantage in life expectancy and wet insulation resistance. Then we sold silicone (Class H) insulation to the manufacturers of electrical equipment ranging from lift truck and traction motors to solenoid and brake coils. We also encouraged the better rewind shops to rebuild hard working industrial motors with Class H insulation.

Now we can proudly refer American industry to this goodly list of electrical manufacturers, all able and willing to supply electric machines protected by Class H insulation made with Dow Corning Silicones.

Take your special problems to the application engineer representing any of these companies or to our Product Development Engineers.

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*"Class H" insulation is the kind of insulation that keeps motors running in spite of "Hell and High water." (slanguage dictionary)

DOW CORNING CORPORATION

DOW CORNING SILICONES

MIDLAND, MICHIGAN

FOR THE BIRDS

BIRD: Stop shaking the pole! You'll scramble my eggs!

MAINTENANCE MAN: But, Mrs. Bird, it's my job to service this light!

Well, be smart and get a THOMPSON HANGER! Then you could lower the light to the ground for servicing. You'd be safer, the company would save a lot of money, and I'd have some peace.

Lower the light? Didn't know it was possible! How would I get it up again? And what about the wiring and electrical hazards?

The THOMPSON HANGER is simplicity itself. All up-and-down movement is controlled by a chain or cable that's part of the installation, and the live electrical contacts stay at the top. What's more, the hanger automatically repositions itself. It's completely safe and absolutely foolproof.

Sounds swell! The boss will buy that! Where can we get all the details?

From the Thompson Electric Co., of course. Write for their new Catalog No. 50. Now, scram and leave me alone. This altitude is for the birds!

Mrs. Bird, in her migratory wanderings, has learned that three important facts are synonymous with THOMPSON HANGER installations: (1) maintenance costs are down to absolute minimum, (2) lighting service men have top safety records and (3) all lights are clean, operating at maximum efficiency to assure better over-all plant operations.

Why don't you, too, write today for the Thompson Electric catalog? There's no obligation.

CATALOG NO. 50 describes THOMPSON HANGERS and accessory items in detail.

171-TE

THE THOMPSON ELECTRIC CO.

1157 Power Avenue • Cleveland 14, Ohio

FOR THE RECORD

Did you know that this issue, with more than 100 pages of editorial material, packed full of forward-looking technical information and profit-building ideas, is the equivalent of a 400 page textbook?

Did you know that 229 advertisers have used this issue to bring you the latest information about products and services that will help you to do a better job ... more efficiently ... more profitably?

This issue is an outstanding example of America's industrial inter-communication system at work: editors and manufacturers working together, promoting the exchange of ideas, to keep you well informed and in step with the rapid cadence of electrical progress.

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New O. Z. CATALOG-PRICE BOOK

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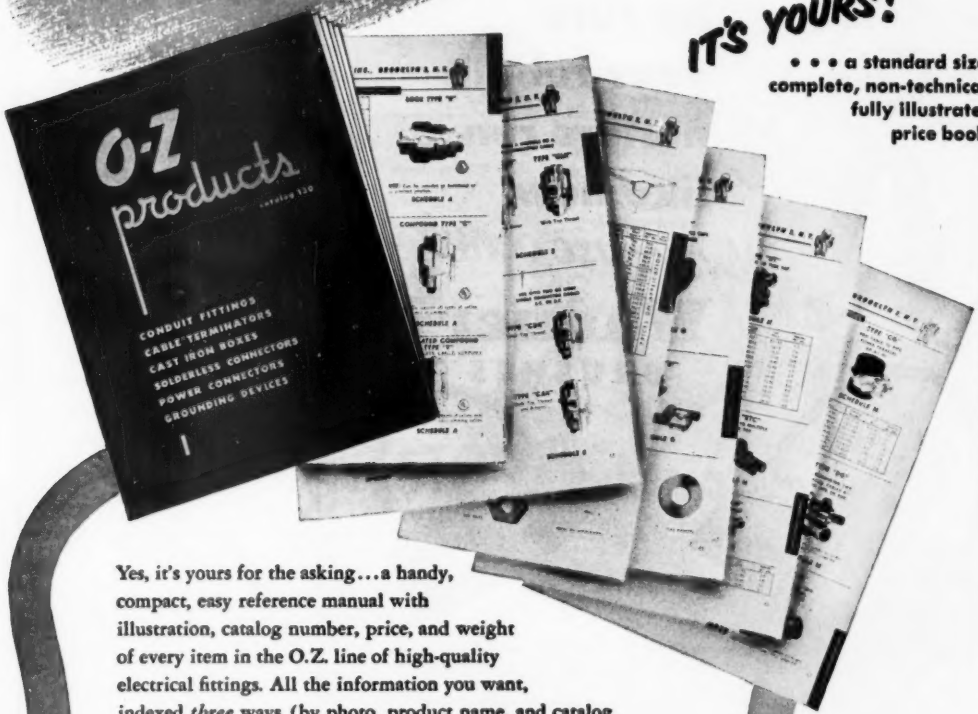

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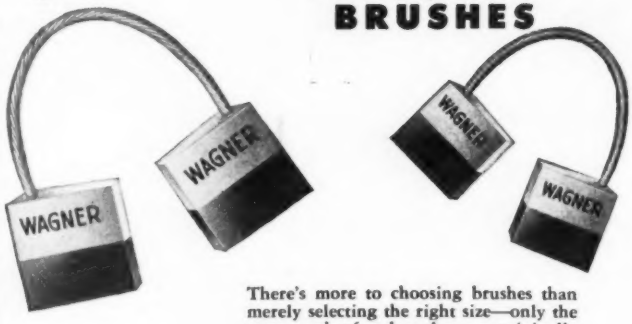

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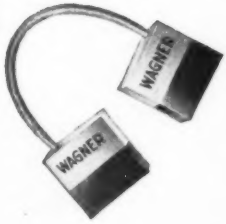

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For heavy loads beyond the call of duty and for controlling mechanisms where small but accurate loads are concerned, Superior silver-refaced contacts have proved their worth. Contact dressing is practically eliminated; frequency of inspection reduced. Puzzling and hard-to-find failures can be eliminated by using Superior's contact rebuilding service. We welcome samples of worn contacts with a full description of the electrical problems involved, so that we can recommend the proper silver alloy for your job.

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"Since 1899" **SUPERIOR** CARBON BRUSHES

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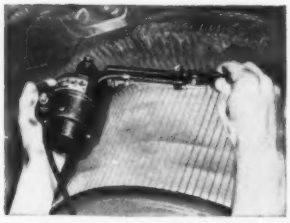

Portable MICA UNDERCUTTER

A light weight—compact—simple unit No. 62, designed for maintenance and service men. Weighs only 3 lbs.—gets into smaller places—undercuts horizontal commutators up to 30" dia., flat up to 11" dia.—has fewer parts and no flexible shafts to get out of order.

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DID YOU KNOW THAT...

In 1950 Electrical Construction and Maintenance published 54 pages of feature articles on lighting?

And that isn't all!

In 1950 Electrical Construction and Maintenance carried more lighting display advertising than any other publication in the field —260 pages to be exact.

CONCLUSION:

For authoritative coverage of lighting . . . articles on design, application, installation and maintenance . . . and for the most complete display of lighting equipment advertising, read every issue of Electrical Construction and Maintenance.

IMPORTANT:

The annual lighting issue will be published in October.

I Quit the Juggling Act by Using
G-E TIME-DELAY RENEWABLE FUSES

Now it's easy to replace fuse links and it only takes a moment. There are only three parts to handle when I renew the link section of a ferrule-type G-E renewable fuse. All I have to do is—unscrew the cap . . . insert a new self-aligning link . . . and replace the cap. It's that simple.

The knife-blade type is just as easy because the slotted ends of the fuse link slip right on the fiber bar support and the new style clip holds it in positive mechanical connection. Then I simply tighten the screws and insert this combination and replace the cap. I'm glad I have no small loose parts to juggle.

I cut emergency calls with...
G-E TIME-DELAY RENEWABLE FUSES

I keep emergency calls at a minimum, now. I find that G-E time-delay renewable fuses "ride-out" noncritical current surges and keep circuits alive. The accurate time delay action saves us needless replacements despite the number of harmless transients so frequently encountered in industrial use. I have less emergency calls because the heavy link sections of G-E time-delay renewable fuses absorb the heat of momentary overloads; but the narrow sections blow fast for shorts and harmful overloads—give us quick protection when we need it. I'm sold on the way G-E time-delay renewable fuses save our time.

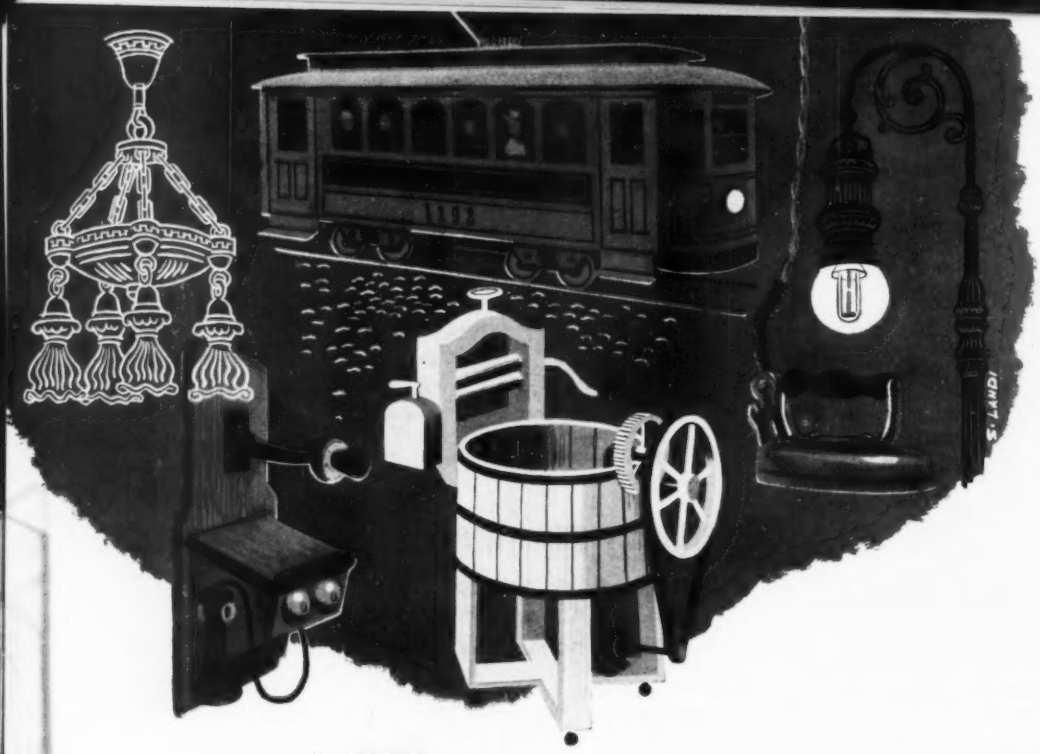
I've standardized on...
G-E TIME-DELAY RENEWABLE FUSES

I've got more time to do other things now, thanks to our program that keeps fuse replacements low. I've standardized on G-E time-delay renewable fuses and always have the full range of sizes on hand to take care of almost every job. I stock complete fuses and renewal links for the ferrule type for 250 v and 600 v in sizes from 3 to 60 amp and the knife-blade type for 250 v and 600 v in sizes from 70 to 600 amp. Now I'm prepared to restore power in a jiffy.

You, too, can get the extra dependable service of the accurate time-delay feature of General Electric renewable fuses. Make sure you stock the sizes for all your commonly-used circuits. If you'd like further information, write to Section D77-718, Construction Materials Division, General Electric Company, Bridgeport 2, Connecticut.

You can put your confidence in—

GENERAL ELECTRIC



Historical Perspective

TODAY'S frontiers of electrical progress are backed up by a long and turbulent history. The firm realities of Ohms law and the cussedness of currents flowing without the restraint of proper circuit protection were dealt with by curiously bewhiskered but able gentry. Their skill and ingenuity at problem solving established a strong tradition fostered by those who followed.

Electrical genius rarely served elementary needs. The industry approached and then quickly surpassed other energy sources in serving them. Oil lamps and gas lights were hardly paled by the early carbon lamps, and sputtering arcs had to make their way against powerful acetylene jets. Combination gas and electric fixtures gave mute testimony to the reliability of wiring systems. Massive steam engines greatly surpassed the feeble horsepower of early industrial motors.

Yet, inexorably, the electrical industry took over larger areas of lighting and power through the years. By the quarter century mark, the gas light was doomed; the line shaft was rapidly becoming obsolete as a means of transmitting power. Individual motor drives inspired controls of ever-increasing accuracy and convenience. And accurate control was only a step away from automatic control.

The thirties opened the era of modern lighting. Light became a measurable commodity to be spread over an area according to whatever standards the seeing task required. And that was only a step from the planned lighting of the forties under fluorescent light. In this same time air conditioning from electric power added another area of control to our environment.

What next? Progress is a certainty. The historical pattern is clear. The momentum is unchallenged. What course the future of the industry will take will be a composite of frontier effort, of initiative and of vision; especially vision.

The fancy-vested contractor of 1901 who looked over a newly finished 50 hp. motor installation and a row of blinding arcs felt the same glow of achievement as his counterpart of 1951 looking down a new row of busy automatic machinery under 100 footcandles of clean illumination. The early work, we know now, was a frontier from which the industry moved forward with undreamed-of progress. If we can believe historical trends, the work of today is only a new and greater frontier facing uncharted opportunity.

HISTORICAL

Five decades from the "hot hairpin" to slimline fluorescents, from open switches to electronic control were colorful years of industry growth and progress.

WE talk today of sharing America's "know-how" with the rest of the world. We mean our skills in production. But more, we mean a way of living that has grown out of knowing how. Extraordinarily, a large part of the knowledge, the tools, the means of creating and using power, has developed in 50 swift years in which we have put electricity to work to do more and more jobs.

At mid-century, we can look back long enough for a fresh perspective.

It would take a thick book merely to list the things that have happened . . . the products developed . . . the men who invented them . . . and the companies that made them.

So this can be only a quick look at five exciting decades as contractors saw them, decades in which the use of electricity nearly doubled each 10 years. In these years, men who installed simple wiring grew up with the industry to work skillfully with complicated plans and mechanisms.

When the century began, the fast-growing electrical industry already called itself a giant. It was a puny giant by today's yardsticks, but with beginnings as colorful and exciting, as full of pioneering as the opening of the west or the building of the railroads.

In 1901, at the turn of the century, the carbon incandescent lamp . . . the "hot hairpin in a bulb" . . . was taking the place of gaslights. Cities found a new brightness in the arc lamp. Mills and factories began to use electric motors instead of steam.

But progress needed a push. Housewives had to be sold. Factory owners had to be argued with, convinced, prodded. Architects were slow to write electrical systems into their plans. Builders of big commercial buildings begrudged even room in the basement for generators! It was a battle still remembered today by some of the oldtimers in the field.

Who were the men who made this fight . . . the contractors who did the installations? Journeymen electricians, mostly. They learned as they worked. They fought the selling battles along with the technical ones. They struggled with plugs that wouldn't fit receptacles, parts that didn't match and all the time new developments were coming fast on top of one another.

The second decade of this century was a time of emerging ideas, feverish research, to make better lamps and motors . . . to get more electric power plants set up in more communities . . . and to extend the distance that power could travel. It was the time of Steinmetz, Westinghouse, Brush . . . men who captured the imagination of the world. It was the day when some of today's biggest companies set up laboratories that grew from barns to vast, sprawling buildings.

Now the contractors, gaining in skill and experience, were joined by men educated in electrical theory and practice. They sold more and more lighting in homes, in stores, to floodlight the Singer building, to light bridges and tunnels with better and better lamps, using tantalum, magnetite, then mercury vapor.

The new gas engine opened up a fresh field—the installation of lighting plants and wiring systems in country homes. The opening of the Panama Canal, electrically controlled, helped to dramatize the practical working success of electricity.

Suddenly, in the twenties, a whole new electrical era began. In the battle of the currents, ac won. It brought improved power transmission and gave a tremendous impetus to industry. With better distribution and greater flexibility, more and better motors, new controls, the industrial age was really humming.

The tungsten lamp made better, cheaper, longer-lasting lighting available. Radio came into important use. The development of electrical refrigerators and ranges, the invention and improvement of a flood of home worksavers, opened up a new "appliance decade."

After 25 years of putting in wiring installations for lighting and powering homes, factories and big buildings since the century's beginning, contractors saw a country underwired for its time with miles of obsolete wiring in need of replacement and modernizing.

Through the rough depression years, the electrical industry fared better than most. Lighting began to expand to new concepts of illumination standards. At the World's Fair, a great display of light provided a dramatic entrance on the scene for the fluorescent lighting that revolutionized lighting practice in the forties.

Organizations At Work

Programs of the two national industry organizations serving electrical construction, installation and maintenance provide a key to current frontier activity.

On July 17, 1901, the National Electrical Contractors' Association of the United States was formed at the Builders Exchange, Buffalo, New York. Thus, there came into being an organization which, down through half a century of progressive development, is known today as the National Electrical Contractors Association, Inc.

At that meeting on that day the form of organization for an enduring trade association was set up. Charles Eidlitz of New York City was elected as the first president of NECA. Death a few weeks ago deprived Mr. Eidlitz of the opportunity of reviewing the 50th anniversary of the organization whose purpose he stated at that time in these words:

"The individual electrical contractor is recognized today as an important factor in building operations in the larger cities, but the trade as a whole has yet to make a place for itself. Our organization can accomplish this end by combined striving in the same direction, by standard methods, up to date work, unanimous action, and by honestly and conscientiously carrying out our contracts can so impress the public that they will be compelled to recognize our efforts. Constant

PERSPECTIVE

striving to increase, improve and better the condition of our trade is absolutely essential for the continued welfare of the organization."

Forty-eight delegates attended this first convention of NECA. They represented 200 contractors, located in New York, Missouri, Pennsylvania, Maryland, Michigan, Ohio and Minnesota.

By contrast, today NECA's membership exceeds 3,100. Members are located in all of the 48 states and Alaska, Puerto Rico and Hawaii. NECA conventions are attended by upwards of 1,000 contractors.

Two things, however, have remained constant down through the years. The problems of electrical contractors today are very similar to what they were 50 years ago. The objectives of NECA, so succinctly stated by President Eidlitz, are today strikingly similar and in many respects identical.

Objectives Of NECA

The basic objective of NECA is two-fold and is on an industry-wide basis:

I. To provide the public with safe, efficient, adequate and economical electrical installations of all types, with due regard to maintaining sufficient qualified contractor organizations to do all types of electrical work at any time and at any place.

II. To bring the benefits of electricity to an increasing number of people through creative selling, thereby providing a sound basis for the progressive growth of the industry and a continuing prosperity for contractors.

These objectives are defined in more detail in the Articles of Incorporation of NECA which state them to be:

(1) To promote and advance the interests of electrical contractors in the installation, alteration, servicing and maintenance of electric wiring, appliances and equipment, including the purchase and sale of electrical products.

(2) To promote qualification of electrical contractors as engineer-salesmen in achieving wider and more efficient distribution and safer and more satisfactory installation of electrical equipment.

(3) To promote a spirit of cooperation and goodwill among the members and their acceptance of fair industry practices.

(4) To collect and disseminate information of value to the industry and to the public, including trade and industry statistics.

(5) To promote sound labor relations on the basis of labor and management cooperation in the public interest.

(6) To promote and cooperate in developing the National Electrical Code and other technical and safety programs having as their object, safe, adequate and improved quality of electric service to the public.

(7) To represent the interests of the industry before legislative assemblies, governmental agencies and other bodies.

(8) To cooperate with other branches of the electrical and construction industries in furthering fair and ethical business practices and in improving products and services.

The Program

The NECA program designed to achieve these objectives is:

I. Influence at the national level all elements of the economic system to perform in a manner that will react to the local benefit of electrical contractors.

II. By educational methods, raise the standards of the Industry, both as to personnel and performance.

III. To provide NECA members on a collective basis with the same type of management service as big business concerns are able to provide for themselves individually.

IV. Encourage members to form chapters for the carrying on of similar activities at the local level.

Activities

The business of electrical contracting is small business; but, in the aggregate, the amount of work done is large; and it is of even greater importance to the economy than the dollar volume and physical amounts would indicate.

The industry has the responsibility for the installations of electrical systems at the point of use of electricity, and, unless this job is done safely and competently, a bottleneck is created which strangles the entire electrical industry.

The electrical contracting industry comprises approximately 12,000 individual enterprises. Few, if any of them, have the complete facilities to attend individually to many essential management details as labor relations; obtaining accurate and rapid information about their industry; research; the latest accounting and cost methods and business administration; and business promotion. For small businessmen contractors, NECA provides these services so essential to the operation of a highly-specialized mechanical contracting business.

The scope of these activities, by departments, follows:

Public Relations:

Development of business. The major business promotional objectives of the association may be summarized in the slogan, "creative selling instead of sole reliance on competitive bidding". Programs are developed and executed to stimulate contractors to create new electrical business by selling their services and the product of electricity to the public.

A cornerstone of the program is the NECA Guarantee Certificate, under which members of the association guarantee their installations for a stated period of at least one year.

A continuing electrical modernization campaign is under way, having been initiated in 1950.

Through this department NECA cooperation with

other branches of the industry in such promotional efforts as Adequate Wiring and Planned Lighting are carried forward.

Information to members.—Information on all aspects of the business and particularly on governmental activities concerning the industry is gathered and distributed. This activity includes the weekly NECA News Letter, Special Service Supplements and Interpretive Bulletins.

Information to the industry.—Information about the electrical contracting industry and NECA is conveyed through the NECA official magazine, "Qualified Contractor", published monthly.

Information to the public.—General information about the industry and the association is presented to the public through press releases, announcements, speeches, radio and television media and in magazines and periodicals.

Interdependence.—Relations with other branches of the electrical industry are maintained for the purpose of advancing the industry generally in the public interest. In this respect contact is maintained with electric utilities, electrical manufacturers and wholesalers, and cooperation in general industry programs is extended. To assist in this endeavor, an industry bulletin, "Joint Venture", is published periodically.

Governmental affairs.—Relations with the federal government are maintained through this department which is represented by personnel registered under the Lobby Registration Act and thus have access to Congress to present the industry's views on legislation and national affairs.

Research and Education:

Two years ago NECA initiated an industry-wide program to train management and technical personnel of contractor organizations. The basic courses are accounting, sales engineering, estimating, job management and business administration.

The preparation of these courses and the administration of the program is under this department, which also conducts staff and liaison work on codes and standards and standardization of product and technique, and the gathering and interpretation of industry statistics and technical data. The NECA Manual of Labor Units is issued through this department, which keeps this material current. It also handles the NECA Research Manual on methods of successful business administration and costing. Representation is maintained on code making committees responsible for the National Electrical Code and for work with the American Standards Association. This Department provides staff facilities and works with the NECA Research and Education, Codes and Standards Committees.

Labor Relations:

The NECA chapters are the collective bargaining units for management in the industry. The function of labor relations is one of the most important activities of NECA. More than 30 years ago, the principle of voluntary arbitration was established by NECA, in cooperation with the International Brotherhood of Electrical Workers, to settle all labor disputes. To do this job, the Council on Industrial Relations for the electrical contracting industry was formed and has been operating since then. Quarterly meetings of this joint agency to resolve controversies are held. One result has been, no general strike of any significant duration has occurred since creation of the Council.

Line Construction:

A special benefit activity is provided in NECA for carrying forward programs designed specifically to assist line construction contractors in their business. There are some basic variations in problems between line constructors and what is known as "inside" contractors, the former being prime contractors.

Motor Repair Industry—NISA

Recognizing the necessity for a better type of service shop, a group of owners of independent electric repair shops organized in 1933 a trade association known as the National Industrial Service Association. Today, this organization has a membership in the neighborhood of 1200 member shops, located throughout the United States and its possessions, and Canada and Cuba. This organization is devoted to improvement of standards of workmanship, to building the prestige of the service industry and is trying to provide the public with dependable service. It was responsible for the introduction of cooperative engineering efforts in the independent repair business. The NISA Research Division and Engineering Department are continuously perfecting their engineering standards and procedures.

NISA holds conventions and regional conferences each year, and an active exchange of ideas takes place among the members during these meetings. This spirit of cooperation and responsibility to the public, together with a strong ethical code, has brought great benefit to the motor repair industry.

There are a great many benefits to be derived from membership in the NISA, and we would like to enumerate some of them for you:

1. NISA activities include the exchange of ideas concerning shop practice, tools, equipment, shop layouts, shop costs, shop data and material.

2. The inspiration developed in talking and associating with fellow members, swapping ideas and experiences with small groups at conventions has done a lot to help the members in the operation of their individual businesses by giving them new ideas and new slants on how the other fellow does the job.

3. Local chapters provide opportunities for frequent discussions on technical subjects and papers on local problems in which the members are interested.

4. One of the most useful things the Association has done for its membership has been the establishment of the NISA Research Division of National Industrial Service Association. It is a voluntary group made up of 65 members of the National Association, who have contributed to its support and maintenance. The purpose of this group is to develop new ideas through research and experiment. The information accumulated and gathered by this division is made available to the entire membership. Pamphlets, literature, rewinding data, and constructive helps are sent to the entire membership.

NISA has over one hundred thousand cards giving rewinding data on most types of polyphase motors that have been manufactured within recent years.

A book of winding data has been printed for 3 phase motors from 1 to 10 hp., a data book of single phase winding, and a book on 15 hp. to 100 hp. A technical loose leaf Service Manual containing information for the shop foreman has been issued.

5. NISA compiles statistical information on overhead, proper balance of various departments of busi-

ness, cost analysis, time studies, and numerous other items which are very valuable in assisting members to know how they are running their business in comparison with others, and whether or not they are operating as economically as they should.

The future of the electric repair industry depends on production and the use of electric power, and as long as both remain high the prospects are bright. In 1950 with 67,174,000 kw of generating capacity the country's output of electrical energy was 399,028,000,000 kwh. This output is expected to continue at an even higher level.

To insure progress and growth, the industry will have to overcome the handicaps of material and manpower shortages, government regulations and other contingencies. Market conditions must be studied, application of engineering research increased, and dynamic specialized salesmanship developed. With foresight, forcefulness, and flexibility, the industry can, with confidence, meet the problems of tomorrow.

What's Ahead

No report of the industry would be complete without some attempt to look forward and to sketch in rough outline a major area of development, which ought to result from the trends of industry progress.

An evolutionary process already taking shape can be characterized as "local refinement and alteration of energy to utilization needs". Through the use of transformers, capacitors, regulators, rectifiers, frequency changers, oscillators, impedances and other apparatus, the wiring system accepts supply at primary voltage, transforms to optimum distribution voltages, then to any desired utilization voltages. Capacitors soak up reactive currents; regulators flatten voltage fluctuation; impedances guard against destructive shorts; rectifiers, frequency changers and oscillators serve dc, high cycle and high frequency requirements, locally at equipment or through separate wiring systems.

Once the principle of refinement and alteration of the supply energy to utilization needs is accepted, wiring design is greatly changed, and there is a new freedom in engineering and application.

Increasing quantities of dc are required for the electrochemical industries and for industrial application of electrochemical processes. Fluorescent ballast design is improved if supplied at approximately 300 volts. Fluorescent lighting systems gain substantially in efficiency if operated at frequencies in the order of 500 cycles. A new light source reaches optimum performance at about 3000 cycles. Superior design and performance of electronic equipment is practical with 400 cycle supply. Motors designed for the high-cycle range are small, light and powerful. A large number of them can be made to respond uniformly to a central control by varying the supply frequency.

With one or more steps of modification occurring between service and utilization, there is likely to be more critical appraisal of the 60 cycle standard. It jelled before the days of high bearing speeds, or steam turbine generation. If future investment in electrical systems will far exceed existing plant and equipment, and all the trends are that way, economical distribution and utilization may well dictate consideration of much higher frequencies.

THIS is the largest single editorial project ever produced by the editors of this publication. It involved many months of preparation. It would have been much more difficult, if not impossible, without the help of many industry authorities who gave freely of their counsel. Any virtues in this report are the result of their efforts to guide us. Any deficiencies are entirely our own.

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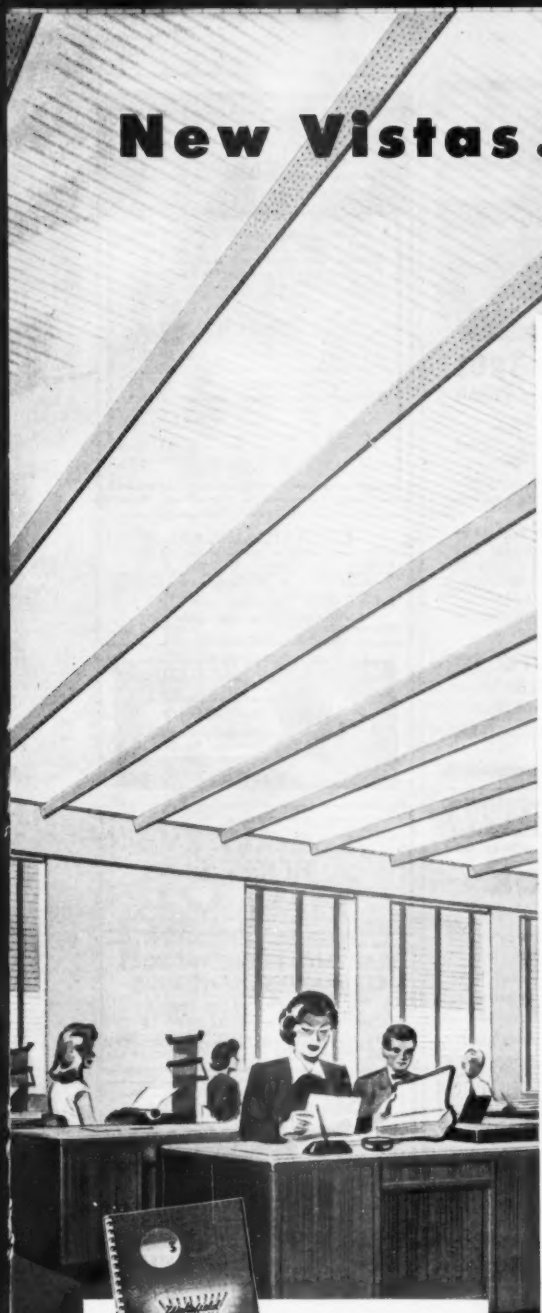

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The F. W. Wakefield Brass Company
Vermilion, Ohio

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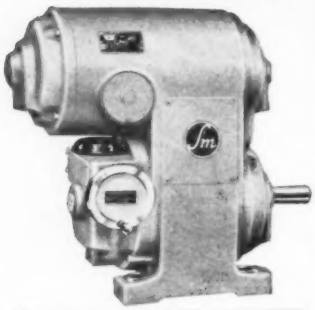
Even a brand new motor may be obsolete . . .

if you do not have control of speed



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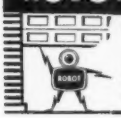

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See Full Line—Page E-5—'51-52 McGraw-Hill Elec. Cat.
ROBOT APPLIANCES, INC.
13166 Prospect—Dearborn, Mich.

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We are working at the highest capacity possible with the limited amount of material available, and are filling orders as promptly as we can.

We are trying, under difficult circumstances, to serve our regular customers and be fair to everyone. We are not interested only in the business of today, but in your future and our future.

Most Complete Line

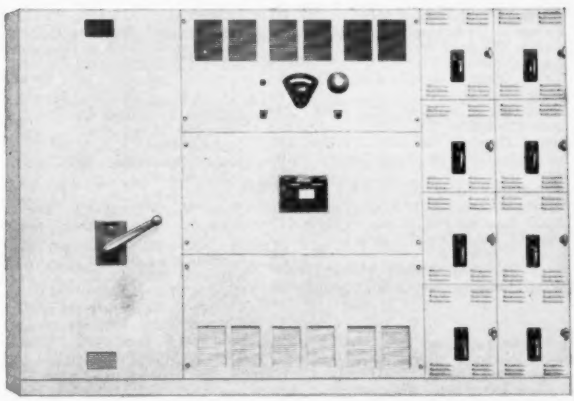
¼ to 2000 Kv-a. All voltages up to 15,000 volts.
Single phase and poly-phase units.
Insulating types and auto transformers.

In addition to our large variety of standard types we build

Special Transformers to meet any special requirement.

Unit Sub-stations Complete with primary and secondary switch gear, metering, and other accessories.

¼ Kv-a Single Phase 460/230 to 230/115 volt



2000 Kv-a. 12,000 volt sub-station, with primary fused load interrupter switch, temperature indicator and alarm, and extra contacts that may be used to operate forced draft fans to increase capacity 25%

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Pioneers in the development and manufacturing of Air Cooled transformers

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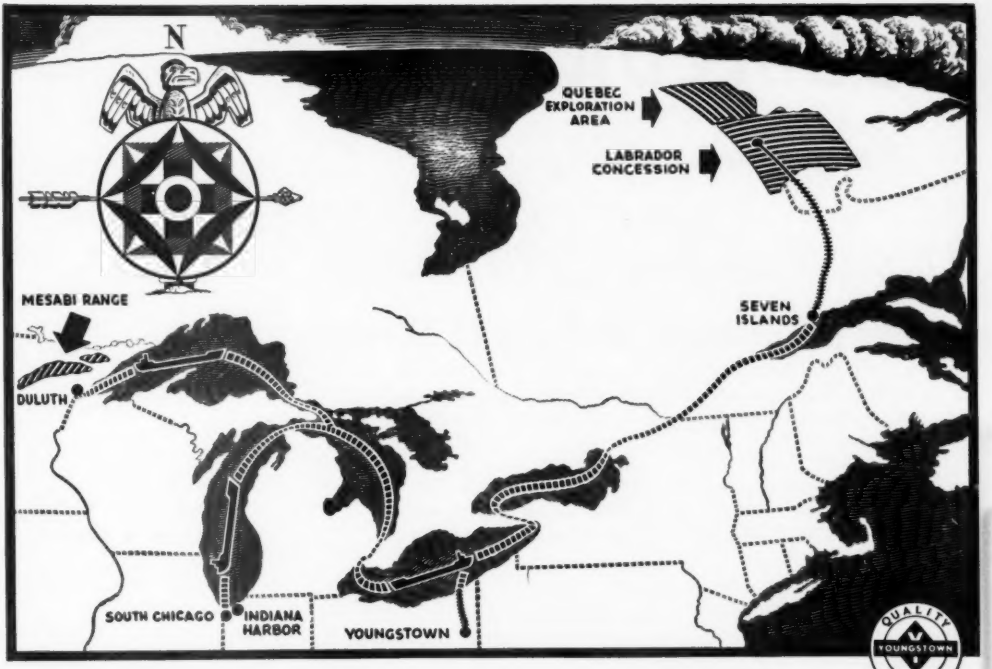


Mister, can you spare Half a Billion Dollars?

ONE half a billion dollars may seem like pin money compared to the sums mentioned for our national finances.

But it is more than three dollars for each man, woman and child in the United States. It is more than the entire steel industry earned in the "dreadful decade" from 1930 to 1939. It's more than America spent to win two wars--the War of 1812 and the Mexican War, combined.

Approximately one half a billion dollars is the estimated sum that a group of steel and mining companies, one of which is The Youngstown Sheet and Tube Company, is investing to guarantee future iron ore supplies for America. In the Mesabi iron range of Minnesota, development projects are under way which will produce millions of tons of iron concentrates from taconite. In Labrador and Quebec, a vast deposit of high grade ore is being developed. Plans include building a 360-mile railroad into the wilderness to ore docks on the St. Lawrence River.

Where does this money come from? From an unnoticed addition to our national debt? From "extra nickels" tucked away in the Federal budget? From more taxes levied on every citizen's income? *Certainly not!* Development of these ore reserves will be financed by each participating Company asking its shareholders to share in its tremendous cost.

America, in peace or in war, is served--now --and for generations to come. This is free enterprise. This is the system that created America from a wilderness and is the only sure way to keep it vigorous and strong.

Scrap Metal is Critical Again

The Youngstown Sheet and Tube Company

General Offices--Youngstown 1, Ohio
Export Offices--500 Fifth Avenue, New York
MANUFACTURERS OF CARBON ALLOY AND YOLOY STEELS

The steel industry is using all its resources to produce more steel, but it needs your help and needs it now. Turn in your scrap, through your regular sources, at the earliest possible moment.

DOUBLEDAY-HILL

Congratulates McGraw-Hill

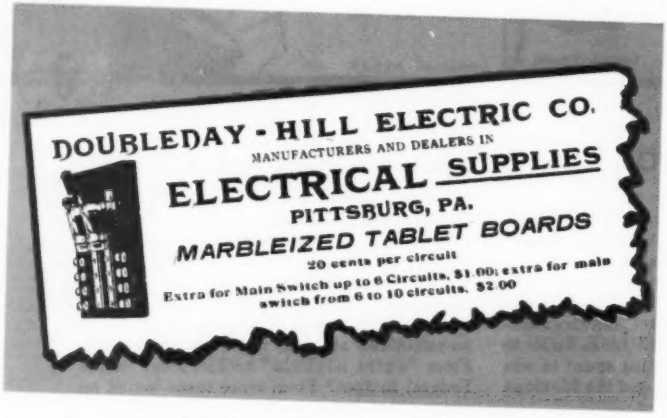
and

Electrical Construction and Maintenance

on this publication's 50 Years of Service

• From Pittsburgh's oldest independent Electrical Wholesaler, since 1884 a distributor of nationally accepted lines for every electrical need.

Today more than ever the Doubleday-Hill organization is dedicated to serving the New Frontiers of our Growth Industry through the Tri-State Area contractors, utilities, industries and institutions.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MANUFACTURERS AND DEALERS IN
ELECTRICAL SUPPLIES
PITTSBURG, PA.
MARBLEIZED TABLET BOARDS
20 cents per circuit
Extra for Main Switch up to 6 Circuits, $1.00; extra for main switch from 6 to 10 circuits, $2.00

One of Doubleday-Hill's messages to Electrical Contractors in its journal of the early 1900's, the "National Electrical Contractor".

Now, after 67 years association with the manufacturers of nationally accepted electrical products, Doubleday-Hill is proud of its record of progress through better sales and service, and constantly improved methods of operation.

DOUBLEDAY-HILL ELECTRIC CO. ELECTRICAL SUPPLIES PITTSBURGH ALL MATERIAL GUARANTEED

DOUBLEDAY-HILL ELECTRIC COMPANY

Wholesale Electrical Supplies

110-112 Seventh Street • • • Pittsburgh 22, Pa.

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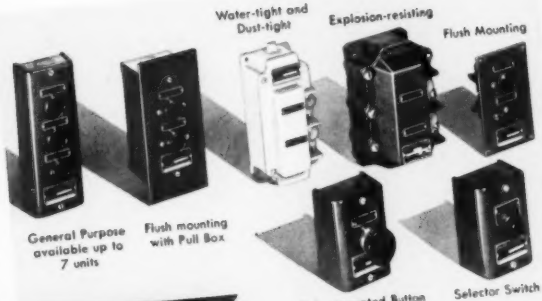
This COMPLETE Line meets every need for Pushbuttons

STANDARD DUTY



HEAVY DUTY

Name your pushbutton requirement—there's a Square D unit to do the job, exactly. Three complete lines . . . standard duty, heavy duty, and oil-tight heavy duty . . . each providing a wide range of operators, stations, and circuit combinations.

Nine Unit Station (available 3, 6, 9, 12, 16 units)
One Unit Station
Two Unit Station
Three Unit Station
Four Unit Station arranged for horizontal mounting

OIL-TIGHT HEAVY DUTY

Write **for Pushbutton Bulletins which give complete details. Address Square D Company, 4041 N. Richards Street, Milwaukee 12, Wisconsin.**

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

Rough, damp operating conditions present no hazards to G-E *White* rigid conduit. Its extra-thick zinc coating—bonded to the steel by the hot-dipped galvanizing method—makes G-E *White* your best buy for lasting wiring protection.

Where are you putting in conduit? Outdoors or in? Exposed to heat or dampness, scorching sunlight or freezing conditions? Fight all these conditions by installing *G-E White* rigid conduit, and you'll know you've prepared for lasting protection.

You'll be interested to know that the hot-dipped galvanized treatment used on *G-E White* actually bonds a heavy coating of zinc to the steel conduit. This zinc combines with the steel and becomes an integral part—not merely a surface finish. That's why the *G-E White* you use gives you tops in service.

And then how about easy wire pulling in those long runs? You've got it with *G-E White*. During treatment the molten zinc is swabbed on the inner surface of the conduit to make a smooth base. Then a glassy smooth surface of Glyptal* lacquer is applied inside and out. This smooth finish means a speedy job with easier wire pulling for you.

Always specify *G-E White* with the double protection—inside and out. Get long-lasting service that defies corrosion. See your General Electric Construction Materials distributor for more information, or write to Section C59-718, Construction Materials Department, General Electric Company, Bridgeport 2, Connecticut.

*Registered Trade Mark of the General Electric Company

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